THE

ANATOMY AND PHYSIOLOGY

OF THE

HUMAN BODY.

BY

JOHN AND CHARLES BELL.

THE SEVENTH EDITION:

IN WHICH THE WHOLE IS MORE PERFECTLY SYSTEMATIZED AND CORRECTED

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THE

ANATOMY

OF THE

HUMAN BODY.

VOL. I.

CONTAINING

THE ANATOMY

OF

THE BONES, MUSCLES, AND JOINTS,

THE HEART AND CIRCULATION,

AND

THE LUNGS.

PREFACE

TO

THE FIRST EDITION.

To those who are at all acquainted with books on anatomy, the appearance of a new one on the subject will not be surprising. To those who are not yet acquainted with such writings, I have only to say, that I have written this book, because I believed that such a one was needed, and must be useful. I have endeavoured to make it so plain and simple as to be easily understood; I have avoided the tedious interlarding of technical terms (which has been too long the pride of anatomists and the disgrace of their science), so that it may read smoothly, compared with the studied harshness, and, I may say, obscurity, of anatomical description. If an author may ever be allowed to compare his book with others, it must be in the mechanical part; and I may venture to say, that this book is full and correct in the anatomy, free and general in the explanations, not redundant, I hope, and yet not too brief.

If, in the course of this volume, I shall appear to have given a place and importance to theories far higher than they really deserve, my reader will naturally feel how useful they are in preserving the due balance between what is amusing and what is useful; between the looser doctrines of functions and the close demonstration of parts. He will be sensible, how much more easily these things can be read in the closet than taught in any public course: he will, I think, be ready to acknowledge, that I introduce such theories only as should connect the whole, and may be fairly distinguished as the physiology of facts; and he will perceive that, in

this, too, I feel a deference for the public opinion, and a respect for the established course of education, which it is natural to feel and to comply with.

Thus, perhaps, it is less immodest for an author to put down what he thinks he may honestly say concerning his own book than to omit those apologies which custom requires, which give assurance, that he has not entered upon his task rashly, nor performed it without some labour and thought, and which are the truest signs of his respect for the public, and of his care for that science to which he has devoted his life.

With these intentions and hopes, I offer this book to the public; and more particularly to those in whose education I have a chief concern; not without a degree of satisfaction at having accomplished what I think cannot fail to be useful, and surely not without an apprehension of not having done (in this wide and difficult subject) all that may be expected or wished for.

Every book of this kind should form a part of some greater system of education: it should not only be entire in its own plan, but should be as a part of some greater whole; without which support and connection, a book of science is insulated and lost. This relation and subserviency of his own particular task to some greater whole, is first in an author's mind: he ventures to look forward to its connection with the general science, and common course of education; or he turns it to a correspondence and harmony with his own notions of study; and if these notions are to give the complexion and character to any book, it should be when it is designed for those entering upon their studies, as yet uncertain where to begin, or how to proceed.

Hardly any one has been so fortunate as to pursue the study of his own science under any regular and perfect plan; and there are very few with whom a consciousness of this does not make a deep and serious impression at some future period, accompanied with severe regret for the loss of time never to be retrieved. In medicine, perhaps, more than in any other science, we begin our studies thoughtless and undecided, following whatever is delightful (as much is delightful), neglect-

ing the more severe and useful parts: but as we advance towards that period in which we are to enter upon a most difficult profession, and to take our place and station in life, and when we think of the hesitation, anxiety, and apprehension with which we must move through the first years of practice, we begin to look back with regret on every moment that is past; with a consciousness of some idle hours; and (what is more afflicting still) with an unavailing sense of much ill-directed, unprofitable labour: — for there is no study which a young man enters upon with a more eager curiosity; but, not instructed in what is really useful, nor seriously impressed with the importance of his future profession, he thinks of his studies rather as the amusement than as the business of life; slumbers through his more laborious and useful tasks, and soon falls off to the vain pursuit of theories and doctrines.

If I were not persuaded of the important consequences, of the infinite gain or loss which must follow the first steps in every profession, I should not feel, but, above all, I should not venture to show, an anxiety, which may be thought affected by those who cannot know how sincere it must be; for, in our profession, this is the course of things, that a young man, who, by his limited fortune, or the will of his friends, by absence from his native country, or by the destination of his future life, is restricted to a few years of irregular, capricious, ill-directed study, throws himself at once into the practice of a profession, in which, according to his ignorance or skill, he must do much good or much harm. Here there is no time for his excursions into that region of airy and fleeting visions, and for his returning again to sedate and useful labour: there is no time for his discovering, by the natural force of his own reason, how vain all speculations are: — in but a few years, at most, his education is determined; the limited term is completed, ere he have learnt that most useful of all lessons — the true plan of study: his opportunities come to be valued (like every other happiness) only when they are lost and gone.

Of all the lessons which a young man entering upon

our profession needs to learn, this is, perhaps, the first, — that he should resist the fascinations of doctrines and hypotheses, till he have won the privilege of such studies by honest labour, and a faithful pursuit of real and useful knowledge. Of this knowledge, anatomy surely forms the greatest share. Anatomy, even while it is neglected, is universally acknowledged to be the very basis of all medical skill. It is by anatomy that the physician guesses at the seat, or causes, or consequences, of any internal disease: without anatomy, the surgeon could not move one step in his great operations; and those theories could not even be conceived, which so often usurp the place of that very science, from which they should flow as probabilities and conjectures only, drawn from its store of facts.

A consciousness of the high value of anatomical knowledge never entirely leaves the mind of the student. He begins with a strong conviction that this is the great study, and with an ardent desire to master all its difficulties: if he relaxes in the pursuit, it is from the difficulties of the task, and the seduction of theories too little dependent on anatomy, and too easily accessible without its help. His desire for real knowledge revives, only when the opportunity is lost; when he is to leave the schools of medicine; when he is to give an account of his studies, with an anxious and oppressed mind, conscious of his ignorance in that branch which is to be received as the chief test of his professional skill; or when, perhaps, he feels a more serious and manly impression, the difficulty and importance of that art which he is called to practise.

Yet, in spite of feeling and reason, the student encourages in himself a taste for speculations and theories, the idle amusements of the day, which, even in his own short course of study, he may observe sinking in quick succession into neglect and oblivion, never to revive; he aspires to the character of a physiologist, to which want of experience and a youthful fancy have assigned a rank and importance which it does not hold in the estimation of those who should best know its weakness or strength. The rawest student, proud of his physiological knowledge, boasts of a science and a name

which is modestly disclaimed by the first anatomist, and the truest physiologist of this or any age. Dr. Hunter speaks thus of his physiology, and of his anatomical demonstration: — "Physiology, as far as it is known or has been explained by Haller, and the best of the moderns, may be easily acquired by a student without a master, provided the student is acquainted with philosophy and chymistry, and is an expert and ready anatomist; for with these qualifications he can read any physiological book, and understand it as fast as he reads.

"In this age, when so much has been printed upon the subject, there is almost as little inducement to attend lectures upon physiology as there would be for gentlemen to attend lectures upon government or upon the history of England. Lectures upon subjects which are perfectly intelligible in print cannot be of much use, except when given by some man of great abilities, who has laboured the subject, and who has made considerable improvements either in matter or in arrangement.

"In our branch, those teachers who take but little pains to demonstrate the parts of the body with precision and clearness, but study to captivate young minds with ingenious speculations, will not leave a reputation that will outlive them half a century.

"I always have studied, and shall continue my endeavours, to employ the time that is given up to anatomical studies as usefully to the students as I can possibly make it, — and, therefore, shall never aim at showing what I know, but labour to show and describe, as clearly as possible, what they ought to know. This plan rejects all declamation, all parade, all wrangling, all subtilty: to make a show, and to appear learned and ingenious in natural knowledge, may flatter vanity; to know facts, to separate them from suppositions, to range and connect them, to make them plain to ordinary capacities, and above all, to point out the useful applications, is, in my opinion, much more laudable, and shall be the object of my ambition."*

* Introductory Lecture published by Dr. Hunter.

EDINBURGH, SEPT. 1795.

PREFACE

TO

THE SIXTH EDITION.

In giving this edition of the Anatomy of the Human Body to the public, I have recast and arranged the whole, and have added several subjects to the original work. I have been careful to revise the descriptions, and have made some additions to them; so that I hope these volumes will be found to have fewer errors, and to present a more perfect system.

Of the first part of the work by my brother, I may speak more freely. And I may recommend it to those who superintend the education of students, to consider whether they have not in it a work calculated to open the minds of the pupils to the right understanding of the important subjects of their studies, and to give them correct and liberal views of their profession. It will not soon be surpassed in correctness and minuteness of description.

I have not dared to touch the History of the Arteries, as delivered by my brother: the rapid improvement in the surgery of the arteries, which followed as a consequence of the first publication of this part of the Anatomy, has, with me, made it sacred. The nervous system is given here as I have taught it in my lectures of late years. And the discoveries which I have made in this department being now acknowledged, I have thought myself at liberty to incorporate the new views of the nervous system with this edition of the System of

Anatomy of the Human Body. I have also introduced, in their proper places, the substance of such essays or observations as I have published from time to time, when they have seemed to deserve this by the interest they have excited.

CHARLES BELL.

Soho-Square, London,
Oct. 1826.

CONTENTS

OF

THE FIRST VOLUME.

ANATOMY

OF THE

BONES, MUSCLES, AND JOINTS.

OF THE SKULL IN GENERAL.

Page

DESCRIPTION OF THE INDIVIDUAL BONES OF THE SKULL.

OF THE MUSCLES.

OF THE MUSCLES OF THE ARM, INCLUDING THE MUSCLES OF THE SCAPULA, ARM, FORE-ARM, AND HAND.

MUSCLES OF RESPIRATION, OR OF THE RIBS.

MUSCLES OF THE HEAD, NECK, AND TRUNK.

OF THE MUSCLES OF THE ABDOMEN, AND OF THE DIAPHRAGM.

OF THE MUSCULAR POWER.

OF THE CELLULAR SUBSTANCE, AND OF THE TENDONS, LIGAMENTS, BURSÆ, AND FASCIÆ, AND ALL THE PARTS WHICH BELONG TO THE BONES OR MUSCLES, OR WHICH ENTER INTO THE CONSTITUTION OF A JOINT.

OF THE JOINTS.

JOINTS OF THE SHOULDER, ARM, AND HAND.

JOINTS OF THE THIGH, LEG, AND ANKLE.

OF THE CIRCULATING SYSTEM.

OF THE

HEART, ARTERIES, AND VEINS.

OF THE HEART.

OF THE MECHANISM OF THE HEART.

INTRODUCTION.

Human anatomy is a part only of a more general science, which embraces the knowledge of the structure of all classes of animals, from the most simple to the highest; but it is by far the most important part. It should be kept before the anatomist and naturalist, as a subject of suitable dignity and usefulness, not only to animate their endeavours, but to give them a direction, and to prove a criterion of their success in the pursuit of useful knowledge. On the other hand, human anatomy cannot be highly cultivated without the assistance of what is called comparative anatomy. It cannot be considered a liberal study, nor properly preserved in relation to general science, without a continual reference to natural history, and the chain of animal existence.

Whether there be a perfect chain and gradation of existence, some will doubt; that is to say, when the naturalist has arranged animals according to their exterior appearance, the anatomist deranges his ideas, by exhibiting, in the internal structure, transitions and gradations which he did not contemplate, and principles of arrangement which he had not foreseen. But this does not controvert the general principle, that there is a chain of existence through the whole of nature. It only throws us back, mortified that we

do not perfectly comprehend the whole system; a conclusion which, however humbling, is exactly what man experiences in the pursuit of every other department of knowledge, whether the subject of his contemplation be the earth he inhabits, the creatures which partake it with him, or his own faculties and nature, and his condition in creation. And let us make the best of this truth; let us view it as promising to us an inexhaustible field for enquiry, and an ever new hope of discovery.

In respect to animals, there are principles in operation, and a structure or organization, which extend, with a certain resemblance, through the whole. There is a system of parts to give form; there is a substance the seat of irritability; there are parts the seat of sensibility and enjoyment; and the powers or endowments of those parts, however different, are supplied through the same means. They have a circulation of fluids more or less perfect (as we use the expression); they receive new matter under the influence of the same appetites; and they perfect or animalize it, and appropriate it, by similar organs.

In all the more perfect animals we have a texture of bones, constituting the skeleton, and giving form and stature; both bearing up the soft parts and protecting them, and at the same time receiving the influence, and adjusting the effects, of the contractile parts of the body: for the bones are moulded with a regard to the motions to be performed, and their shapes give a direction to the efforts of the muscles.

The muscles constitute, properly, the fleshy part of the body. They consist of a fibrous texture, and are possessed of a peculiar animal and living power of contraction: in them, motion is originated by

the influence of nerves; and by their operation on the bones, the motions and agency of the body are produced.

The nerves are like white cords, which are every where traceable through the body, where sensibility and motion can be perceived. They extend betwixt the brain and the muscular frame, combine the muscles in their actions on the bones and joints, and convey to them the influence of the will.

But these muscles and nerves have powers peculiar to them as living parts. All living properties are continued and propagated through the influence of the circulating blood: so that, although in the nerves, muscles, and bones, we see all that is necessary to the mechanism of the frame, we find every where accompanying them, arteries, veins, and lymphatics, which are necessary to their constitution as living parts.

To knit the bones together, and form the articulations, to be a bed and proper support for the muscles, to constitute a general bond of union betwixt bones, muscles, nerves, and blood-vessels—a certain cellular texture is necessary. This common cellular substance extends over the whole frame, unites the rudest parts, as the bones, and sustains the most delicate vessels, and such as are not visible to the naked eye; it constitutes, therefore, a very large proportion of the body, and is common to all animals.

Still, in what is here described, we have only the common textures of the frame of animal bodies; and, suppose them so constituted and possessed of their endowments, to feel or suffer, to re-act and to move symmetrically, how are these powers to be continued, and the delicate textures to be preserved? This consideration leads to the second division of the Anatomy.

the VISCERA; the organs which are for the reception and assimilation of new matter.

To the circumstances of volition and locomotion, is owing the necessity for an alimentary canal. The vessels of vegetables, extended in their roots, draw nourishment from the soil; but animals must have these vessels and absorbing mouths internal, and the nutritious matter conveyed to them through an intestinal canal. In this canal, various processes are performed, suiting the contained matter to its new condition, and fitting it to be received into the living vessels, and gradually assimilating it to the condition of the circulating blood. In man, the food requires no preparation but of mastication, and is directly carried into a digesting stomach. Digestion is the first and the most essential change wrought upon the food: after that it is sent into the intestines, and subjected to the operation of certain secreted fluids, which separate, and, as it were, refine off the pure and nutritious fluid. It is then subjected to the absorbent mouths of the lacteals of the intestines, by a process as curious as any to be observed in the animal functions, and incapable of being explained on the common principles of fluids acting on dead matter out of the body. By the lacteals, the fluid destined to supply the waste of the body is carried into the circulating system.

The CIRCULATING SYSTEM consists of heart, arteries, and veins, a set of tubes continuous throughout, which transmit the blood through the whole body. The blood is sent outward by the arteries, and returns by the veins, and thus moves in a continual stream, urged on by the contraction of the containing tubes and cavities.

In animals which have a circulation, the blood is a vehicle which is constantly receiving from the

alimentary canal, what it furnishes to all parts of the body for their growth. It is in its distribution to the extremities of the arteries that it effects those purposes of nutrition. In the very lowest animals, some physiologists have persuaded themselves that the vessels carry the fluid directly from the stomach to the parts of the frame, to nourish them. But in the more perfect animals, we know that it is not so.

The new fluid which has come from the organs of digestion and assimilation, is not fit for the purposes of nutrition until it has suffered the influence of the lungs. Nor is the blood which returns from the body by the veins, capable of sustaining the endowments or properties which distinguish the different textures as living parts, until it be submitted to the same operation.

Lungs, therefore, are an essential part of the organic functions of all living beings. Vegetables, and those animals which have no true circulation, respire through the whole of their surface, or they have the air admitted into the interior of their bodies through different foramina, and by air-vessels, which accompany the blood-vessels in their distribution to the body. It is a beautiful display, to see minute tubes distributing air and mingling with those carrying blood, as if they were as necessary to the health and exercise of the living properties, as the blood-vessels themselves. And so it is proved by the survey of animated nature, to be in some way essential to the existence of life, that the blood and the pure air shall mutually influence each other.

In the more perfect animals, the lungs admit the air into contact with the blood. They consist of innumerable cells, having connexion with the windpipe or trachea, and by the muscular apparatus of the chest or thorax, these cells are expanded and

compressed alternately; so that the atmospheric air is permitted to press or sink into these cells in inspiration, and is again discharged in expiration. To the cells of the lungs, a grand division of the circulating system of vessels is transmitted: arteries carrying the blood to them, and veins returning that blood again to the heart. And by means of these vessels the blood in the lungs is exposed to the influence of the atmospheric air, and through its influence it is purified.

This is the meaning of what is termed the double circulation, and the double heart; for in the higher and warm-blooded animals, there is a heart, consisting of two cavities, for receiving the blood from the body and transmitting it to the lungs, and there is another heart of two cavities for receiving the blood from the lungs and transmitting it to the body. These four cavities are tied together by the interlacement of their muscular fibres; and their walls, being animated by the same nerves, are in every respect combined, and subject to the same excitement: so that as the principal force of circulation is in the heart (for so we call the union of the four cavities), the circulation in the body and the circulation in the lungs are regulated by the heart's excitement, and always correspond.

The air respired must contain oxygen, or vital air; the air returned from the lungs is loaded with carbonic acid gas. The blood which had received the operation of the oxygen upon it was venous, dark-coloured, and unfit for the offices of life; but, on returning from the lungs, it has parted with its carbon,—it has become purer in colour; it is the bright vermilion-coloured blood which, from its being transmitted through the body by the arteries, is called arterial blood.

No animals respire by a particular organ except those that have a real circulation of the blood; because, in them, the heart and vessels are so ordered, that no blood is transmitted to the body, unless the whole or part has been subjected to the offices of the lungs and purified, and made capable, not merely of conveying the nutriment and material of the bodily frame, but also of supporting the vital energies, whatever these may be. Whether it is the nerve which has to feel, or the muscle to contract, no quality of life can be long supported in the organ without the supply and actual contact of the pure or arterial blood.

In this introductory survey of the animal œconomy, we perceive that the functions may be divided into three distinct orders.

We perceive that if animals required no supply, and if they held an independent existence, the faculties of sensation and motion would suffice, and nerves and muscles would constitute the whole active frame. These are the functions which anatomists call the animal functions, by which we might suppose the lower properties of our nature were meant; but the term is used in contra-distinction to vegetable life, which enjoys neither sense nor motion.

In opposition to the animal functions, are the vital functions, by which are meant, those which serve for the preservation and renovation of the machine; such as the offices of digestion, absorption, circulation, respiration, and the excretions.

Finally, the duration of each individual is defined and limited. There is a continual change and renovation of the frame, an intestinal or internal motion, a separation and an absorption of its particles, by which the body is ever new; but the life, the active principle, suffers change in infancy, youth, maturity, and

the debility of age and death. Such is the law of animal existence. By which we see the necessity of a system of superadded parts, and a third order of functions: organs of generation, by which the individuals that perish, are replaced by others, and by which the existence of each species of animals is maintained.

On the whole, and surveying what is common to all animals, we perceive,—and all men who do not allow their passions to interfere with their philosophical opinions must acknowledge,—that there is a principle of life which holds those bodies that enjoy it, subjected to a law different from that which governs inanimate matter; and that the principal character of this power is to withdraw the bodies it animates, from the influence of those mere chemical affinities, to which, from the multiplicity of their component parts, their mixture, moisture, and temperature, they would have a strong tendency, and to which they are immediately exposed on death, and whereby their textures are reduced to their original elements.

OF THE SKELETON.

The skeleton is the assemblage of bones which sustains the soft parts, and gives form to the human body. The bones may be contemplated in their three offices:—1. As columns under the weight of the parts;—2. As levers on which the muscles act, to give activity and locomotion;—and, 3. As a covering and protection to the softer and more delicate organs. In all the higher links of the chain of animal existence, there is a texture resembling the composition of bone, to sustain or protect the soft parts. In the corals, we may see a skeleton common to the whole family. In *testacea* it is an external shell, a calcareous foliated texture for their protection. In creatures that creep, the muscles are attached to their skin; while in the *crustacea* there is a calcareous crust, which is at once skin and skeleton, since the shell is in distinct parts, and articulated, and these parts have the muscles inserted into them. In reptiles and fishes, there is an internal system of bones, or a true skeleton. The peculiarity of their skeleton is not merely in the form and arrangement of the bones, but in their possessing more elasticity than belongs to the skeleton of birds and quadrupeds.

The thing most admirable in the composition of the skeleton, is the relation of its parts; the manner in which all its parts are cast at once, forming a system which, in our methods of proceeding, we are

apt to forget. For, studying the individual bones with great minuteness, we neglect the relation which is established betwixt all the parts of the skeleton of any one animal.

If the reader turn to the Review of the Skeleton, he will perceive that a system pervades all animated nature; but in the mean time it may be more proper for him to consider the structure of one of the long bones.

That the bones, which form the interior of animal bodies, should have the most perfect shape, combining strength and lightness, ought not to surprise us, when we find this in the lowest vegetable production.

In the sixteenth century, an unfortunate man who taught medicine, philosophy, and theology, was accused of atheistical opinions, and condemned to have his tongue cut out, and to suffer death. When brought from his cell before the Inquisition, he was asked if he believed in God. Picking up a straw which had stuck to his garments, "If," said he, "there was nothing else in nature to teach me the existence of a Deity, even this straw would be sufficient!"

A reed, or a quill, or a bone, may be taken to prove that in Nature's works strength is given with the least possible expence of materials. The long bones of animals are, for the most part, hollow cylinders, filled up with the lightest substance, marrow; and in birds the object is attained by means (if we may be permitted to say so) still more artificial. Every one must have observed, that the breast-bone of a fowl extends along the whole body, and that the body is very large compared with the weight: this is for the purpose of rendering the creature specifically lighter and more buoyant in the air; and that it may have a surface for the attachment of muscles, equal to the exertion of raising it on the wing. This combination of lightness with increase of volume, is gained by air-cells extending through the body, and communicating by tubes between the lungs and cavities of the

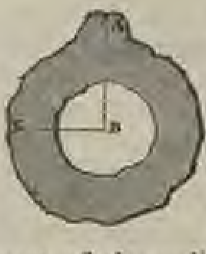
bones. By these means, the bones, although large and strong, to withstand the operation of powerful muscles upon them, are much lighter than those of quadrupeds.

The long bones of the human body, being hollow tubes, are called cylindrical, though they are not accurately so, the reason of which we shall presently explain; and we shall, at the same time, show that their irregularities are not accidental, as some have imagined. But let us first demonstrate the advantage which, in the structure of the bones, is derived from the cylindrical form, or a form approaching to that of the cylinder. If a piece of timber supported on two points, thus —

bear a weight upon it, it sustains this weight by different qualities in its different parts. For example, divide it into three equal parts (A, B, C): the upper part A supports the weight by its solidity and resistance to compression; the lowest part B, on the other hand, resists by its toughness, or adhesive quality. Betwixt the portions acting in so different a manner there is an intermediate neutral, or central part, C, that may be taken away without materially weakening the beam, which shows that a hollow cylinder is the form of strength. The author lately observed a good demonstration of this: — a large tree was blown down, and lay upon the ground; to the windward, the broken part gaped; it had been torn asunder like the snapping of a rope: to the leeward side of the tree, the fibres of the stem were crushed into one another and splintered; whilst the central part remained entire. This, we presume, must be always the case, more or less. And here we may take the opportunity of noticing why the arch is the form of greatest strength. If this transverse piece of timber were in the form of an arch, and supported at

the extremities, then its whole thickness, its centre, as well as the upper and lower parts, would support weight by resisting compression. But the demonstration may be carried much farther to show the form of strength in the bone. If that part of the cylinder which bears the pressure be made more dense, the power of resistance will be much increased; whereas, if a ligamentous covering be added on the other side, it will strengthen the part which resists extension: and we observe a provision of this kind in the tough ligaments which run along the vertebræ of the back.

When we see the bone cut across, we are forced to acknowledge that it is formed on the principle of the cylinder; that is, that the material is removed from the centre, and accumulated on the circumference, thus *—



We find a spine, or ridge, running along the bone, which, when divided by the saw in a transverse direction, exhibits an irregularity, as at A. The section of this spine shows a surface as dense as ivory, and it is, therefore, much more capable of resisting compression than the other part of the cylinder, which is common bone. This declares what the spine is; and those anatomists must be wrong who imagine that the bone is moulded by the action of the muscles, and that the spine is a mere ridge, arising by accident among the muscles. It is, on the contrary, a strengthening of the bone

* See Munro's Works, p. 45. "Since the united force of all the fibres is to be regarded as resisting at a distance from the centre of motion equal to the semi-diameter, it follows that the total resistance of all these fibres, or the strength of the bone, is proportional to its semi-diameter, and consequently to its diameter." This proposition has been demonstrated mathematically, by Dr. Porterfield, in the Medical Essays of Edinburgh, vol. i. art. 10.

in the direction on which the weight bears.* If we resume the experiment with the piece of timber, we shall learn why the spine is harder than the rest of the bone. If a portion of the upper part of the timber

be cut away, and a harder wood inserted in its place, the beam will acquire a new power of resisting fracture, because, as we have stated, this part of the wood does not yield but by being crushed, and the insertion of the harder portion of wood increases this property of resistance. With this fact before us we may return to the examination of the spine of bone. We see that it is calculated to resist pressure, first, because it is farther removed from the centre of the cylinder; and, secondly, because it is denser, to resist compression, than the other part of the circumference of the bone.

This explanation of the use of a spine upon a bone gives a new interest to osteology. The anatomist ought to deduce from the form of the spine the motions of the limb; the forces bearing upon the bone, and the nature and the common place of fracture: while, to the general enquirer an agreeable process of reasoning is introduced in that department, which is altogether without interest when the "*irregularities*" of the bone are spoken of, as if they were the accidental consequences of the pressure of the flesh upon it.

Although treating of the purely mechanical principle, it is, perhaps, not far removed from our proper object to remark, that a person of feeble texture and indolent habits has the bone smooth, thin, and light; but that Nature, solicitous for our safety, in a manner

* As the line A B extends farther from the centre than B C, on the principle of a lever, the resistance to transverse fracture will be greater in the direction A B than B C.

which we could not anticipate, combines with the powerful muscular frame a dense and perfect texture of bone, where every spine and tubercle is completely developed. And thus the inert and mechanical provisions of the bone always bear relation to the muscular power of the limb, and exercise is as necessary to the perfect constitution of a bone as it is to the perfection of the muscular power. Jockies speak correctly enough, when they use the term "*blood and bone*," as distinguishing the breed or genealogy of horses; for blood is an allowable term for the race, and bone is so far significant, that the bone of a running horse is remarkably compact compared with the bone of a draught horse. The reader can easily understand, that the span in the gallop must give a shock in proportion to its length; and, as in man, so in the horse, the greater the muscular power, the denser and stronger is the bone.

The bone not being as a mere pillar, intended to bear a perpendicular weight, we ought not to expect uniformity in its shape. Each bone, according to its place, bears up against the varying forces that are applied to it. Consider two men wrestling together, and then think how various the properties of resistance must be: here they are pulling, and the bones are like ropes; or again, they are writhing and twisting, and the bones bear a force like the axle-tree between two wheels; or they are like a pillar under a great weight; or they are acting as a lever.

To withstand these different shocks, a bone consists of three parts, the *earth* of bone (phosphate of lime) to give it firmness; *fibres* to give it toughness; and *cartilage* to give it elasticity. These ingredients are not uniformly mixed up in all bones; but some bones are hard, from the prevalence of the earth of bone; some more fibrous, to resist a pull upon them; and some more elastic, to resist the shocks in walking, leaping, &c.

But to return to the forms:—Whilst the centre of the long bones is, as we have stated, cylindrical, their extremities are expanded, and assume various shapes. The expansion of the head of the bone is to give a greater, and consequently a more secure surface for the joint, and its form regulates the direction in which the joint is to move. To admit of this enlargement and difference of form, a change in the internal structure of the bone is necessary, and the hollow of the tube is filled up with *cancelli*, or lattice-work. These *cancelli* of the bone are minute and delicate, like wires, which form lattice-work, extending in all directions through the interior of the bone, and which, were it elastic, would be like a sponge. This texture of the bone permits the outer shell to be very thin, so that whilst the centres of the long bones are cylinders, their extremities are of a uniform cancellated structure. But it is pertinent to our purpose to notice, that this minute lattice-work, or the cancelli which constitute the interior structure of bone, have still reference to the forces acting on the bone; if any one doubts this, let him make a section of the upper and lower ends of the thigh-bone, and let him inquire what is the meaning of the difference in the *lay* of these minute bony fibres, in the two extremities? He will find that the head of the thigh-bone stands obliquely off from the shaft, and that the whole weight bears on what is termed the *inner trochanter;* and to that point, as to a buttress, all these delicate fibres converge, or point from the head and neck of the bone.

There is another circumstance of more practical importance, connected with the difference of texture of the bone in its diaphysis and epiphysis, that is, in its centre and its extremities. Different effects will be produced by violence; for example, by gun-shot. A musket-ball will sink into the head of the bone and lodge there, or pass quite through it; whereas if it strike the centre, it will split it up and break it into twenty pieces. Of this the reader may find examples

in the Museum of the College of Surgeons of Edinburgh, which specimens I took from the wounded at Corunna and at Waterloo. It is probably owing to the looser texture of the extremities of the long bones that true necrosis does not take place in them, but only in the diaphysis.

Some, with a singular unhappiness of disposition, will contemplate the chain of animal existence, and see in it only a mechanical principle of adherence to a certain original type or model; and they have more gratification in giving a catalogue of things useless (that is to say, of parts, the beauty or usefulness of which they do not comprehend), than of contemplating the whole, and allowing their minds to receive that natural influence which the system of nature is calculated to produce.

The four divisions of the upper extremity exist in all the anterior extremities of the class mammalia. A curious inspection of the gradations will prove that parts dissimilar in form, are a new appropriation of the same bones. In the fin of a whale we may recognize the bones of the human hand. Strip the integuments off the anterior fin of the dolphin or porpoise, and we recognize, somewhat disordered, a scapula, humerus, fore-arm, and carpus, metacarpus, and finger bones. It should surprise us less, that in the wing of a bird we should see the bones of the anterior extremity of a quadruped; or recognize, in the fine bones which stretch the membraneous wing of a bat, the phalanges of the fingers. Although there be no resemblance betwixt the outer form of animals that walk, and those that fly, and those that creep, yet in all of them the skeleton is recognizable as the same system of bones, variously modified.

But the question returns upon us,—can there be an adaptation of parts better calculated to their end, or more obviously designed, or better evidence of a system pervading all nature, and that the whole has been cast out at once from a power omnipotent?

There is not a more curious proof of adaptation of the texture of the skeleton to the condition and habits of animals, than we have in the bones of birds and fishes. In the former, as we have said, the dimensions, and consequently the strength, are increased without adding to the weight, by admitting a communication betwixt the lungs and the cavities of the bones, by which air is admitted into them. In fishes, the bones are light, not only by having a lesser quantity of earth in their composition, but by having spermaceti or oil deposited in their cavities. In the spermaceti whale, the head is kept buoyant, and the blow-holes above the water, by a large quantity of the spermaceti lodged in the head.

The bones of the human skeleton have been divided into the flat and cylindrical bones. It is incorrect, and therefore unscientific. Their forms are too much varied to admit of this sort of arbitrary division. There can be no other division of the skeleton, than into, 1. The bones of the trunk. 2. The bones of the extremities. 3. The bones of the head.

The bones are united in a manner varying with their forms and uses. They are immoveably joined together, by having their processes fixed into corresponding cavities, like cabinet-work; or, where the texture of bone is delicate, they are simply laid together, and a line marks their union; or they are laid over each other, and spliced together; or conical processes are, in a manner, inserted into corresponding cavities, like a nail; or the bones are firmly joined, yet so as to give some elasticity, and to take off the jar of contact, by intermediate cartilage. Finally, the bones are constituted with a relation to free motion at their articulation: for which purpose their extremities are covered with smooth cartilage, and joined by ligaments.

Immobilis junctura sive synarthrosis, viz. 1. Sutura. 2. Harmonia. 3. Sutura Squamosa. 4. Gomphosis. 5. Synchondrosis.

6. Diarthrosis sive mobilis junctura.

It is an interesting subject of study, to consider the uses of the parts, and to observe with what

felicity and curious skill (so would we express ourselves of things of human invention) the strength, forms, and processes of the bones are adapted.*

* The young student, before entering on the demonstration of the bones, should make himself familiar with the meaning of such terms as the following: *Fovea, Fossa, Cella, Sinus, Fissura, Sulcus, Foramen, Meatus, Cervix, Condylus, Apophysis, Spina, Crista, Stylus,* &c. Let him look up these words in his dictionary. For although this anatomy is written with a desire to substitute the full and pure English description for the barbarism of the terms used in anatomical works, it is not always possible to avoid the use of such terms, in describing the infinite varieties in the form of bones. Indeed, the student ought to know these terms; and yet in communication and consultation it shews a better educated man to prefer the English language, if it can be made sufficiently descriptive.

OF THE TRUNK.

THE BONES OF THE SPINE, PELVIS, AND THORAX.

The demonstration of the bones should begin with those of the spine, as it is the centre of muscular action, and the part of most common relation; for the spine is placed upon the arch of bones which form the pelvis, and supports the head, and is at the same time the bond of union of the bones of the thorax or chest.

The bones of the trunk consist of these: the chain of bones forming the vertebral column or spine; the bones of the pelvis; the ribs; and the sternum or breast-bone.*

OF THE SPINE.

Uses of the spine.

The spine is so named from certain projecting points of each bone, which, standing outwards in the back, form a continued ridge; and the appearance of continuity is so complete, that the whole ridge is named spine, which, in common language, is spoken of as a single bone. This long line consists

* The reader may peruse the dissertation *on the formation and growth* of bone, before studying the forms and processes of the skeleton. But as the subject is abstruse, it has been (in this edition) introduced at the end of the anatomy of the bones.

of twenty-four distinct bones, named vertebræ, from the Latin vertere, to turn. They conduct the spinal marrow, secure from harm, the whole length of the spine, and support the whole weight of the trunk, head, and arms; they perform, at certain points, the chief turnings and bendings of the body; and do not suffer under the longest fatigue, or the greatest weight which the limbs can bear. Hardly can any thing be more beautiful or surprising than this mechanism of the spine, where nature has established the most opposite and inconsistent functions in one set of bones; for these bones are so free in motion, as to turn continually, yet so strong, as to support the whole weight of the body; and so flexible, as to turn quickly in all directions, yet so steady withal, as to contain and defend the most material and the most delicate part of the nervous system.

Classification of the 24 vertebræ. The vertebræ are arranged according to the neck, back, and loins, and the number of them corresponds with the length of these divisions. Five of the loins. The vertebræ of the LOINS are five in number, very large and strong, and bearing the whole weight of the body. Their processes stand out very wide and free, not entangled with each other, and performing the chief motions of the trunk. Twelve of the back. The vertebræ of the BACK are twelve in number. They also are big and strong, yet smaller than those of the loins; their processes are laid over each other; each bone is locked in with the next, and embarrassed by its connexion with the ribs: this is, therefore, the steadiest part of the spine; a very limited motion only is allowed. Seven of the neck. The vertebræ of the NECK are seven in number; they are more simple, and like rings; their processes hardly project; they are very loose and free; and their motions are the widest and easiest of all the spine.

The seven vertebræ of the neck, twelve of the back, and five of the loins, make twenty-four in all, which is the regular proportion of the spine. But the number is sometimes changed, according to the proportions of the body; for, where the loins are

long, there are six vertebræ of the loins, and but eleven in the back; or the number of the pieces in the back is sometimes increased to thirteen; or the neck, according as it is long or short, sometimes has eight pieces, or sometimes only six. However, these varieties are very rare.

The general form, processes, and parts of the vertebræ are best exemplified in a vertebra of the loins; for in it, the body is large, the processes are right-lined, large, and strong; the joint is complete, and all its parts are very strongly marked. Every vertebra consists of a body, which is firm, for supporting the weight of the body, and hollow behind, for transmitting the spinal marrow: of two articulating processes above, and two below, by which it is jointed with the bones which are above and below it: of two transverse processes, which stand out from either side of the bone, to give hold and purchase to those muscles which turn the spine; and of one process, the spinous process, which stands directly backwards from the middle of the bone: and these processes being felt in distinct points all the way down the back, give the whole the appearance of a ridge; whence it has the name of spine. General description of a vertebra.

The BODY of the VERTEBRA is a large mass of soft and spongy bone; it is circular before, and flat upon the sides. It is hollowed into the form of a crescent behind, to give the shape of that tube in which the spinal marrow is contained. The body has but a very thin scaly covering for its thick and spongy substance. It is tipped with a harder and prominent ring above and below, as a sort of defence; and within the ring, the body of the vertebra is hollowed out into a sort of superficial cup, which receives the ligamentous substance, by which the next vertebra is joined to it; so that each vertebra goes upon a pivot, and resembles the ball and socket joints. And in many animals it is distinctly a joint of this kind. Particular description of the body. Shape. The harder ring; hollowed above and below.

On the fore and back part of the body of the Foramina.

vertebra are several holes, which are for the transmission of blood-vessels and for the attachment of ligaments.*

The BODY is the main part of the vertebra, to which all the other processes are to be referred: it is the centre of the spine, and bears chiefly the weight of the body: it is large in the loins, where the weight of the whole rests upon it, and where the movements are rather free: it is smaller in the vertebræ of the back, where there is almost no motion and less weight; and in the vertebræ of the neck, there is hardly any body, the vertebræ being joined to each other chiefly by the articulating processes.

The arch. The ring or circle of bone, or the arch which, together with the body itself, forms this circle, next attracts our notice; for the arches of the vertebræ, forming a continued tube, give passage to the spinal marrow. (The notch.) We observe a notch on each side of the arch for transmitting the nerves which go out from the spinal marrow.

The articulating process. The ARTICULATING PROCESS is a small projection, standing out obliquely from the body of the vertebra, with a smooth surface, by which it is joined to the articulating process of the next bone; for each vertebra has a double articulation with that above and with that below. The bodies of the vertebræ are united to each other by a kind of ligament, the intervertebral substance, which forms a more fixed, and rather an elastic joining; and they are united again by the articulating processes, which make a very moveable joint of the common form. (called also oblique.) The articulating processes are sometimes named oblique processes, because they stand rather obliquely. The upper ones are named the ascending oblique processes, and the two lower ones are named the inferior or descending oblique processes.

The spinous processes. The SPINOUS PROCESSES are those which project directly backwards, whose points form the ridge of

* These foramina enlarge in the beginning of the scrofulous inflammation of the bone.

the back, and whose sharpness gives the name to the whole column. The body of each vertebra sends out two arms, which, meeting behind, form an arch or canal for the spinal marrow; and from the middle of that arch, and opposite to the body, the spinous process projects. Now the spinous, and the transverse processes, are as so many handles and levers, by which the spine is to be moved; which, by their bigness, give a firm hold to the muscles, and, by their length, give them a powerful lever to work their effects by. The spinous processes, then, are for the insertion of these muscles, which extend and raise the spine, and for the attachment of a ligament which runs from point to point in the whole length of the spine, and which checks the bending of the trunk forward.

Transverse processes.

The TRANSVERSE PROCESSES stand out from the sides of the arms or branches (named *crura*) which form this arch. They stand out at right angles, or transversely from the body of the bone; and they also are as levers, and long and powerful ones, for moving and turning the spine. Perhaps their chief use is not for turning the vertebræ, as there is no provision for much lateral motion in the lower part of the spine; but the muscles which are implanted into these are more commonly used in assisting those which extend and raise the spine.

These, and all the processes, are more distinct, prominent, and strong, more direct, and larger in the loins, and more easily understood, than in the vertebræ of any other class. But this prepares only for the description of the individual vertebra, where we find a variety proportioned to the various offices and to the degrees of motion which each class has to perform.

Peculiarities of a lumbar vertebra.

Of the VERTEBRÆ OF THE LOINS.—I have chosen to represent the general form of a vertebra, by describing one from the loins, because of the distinctness with which all its parts are marked. In the lumbar vertebræ, the perpendicular height of the body is comparatively less, the intervertebral sub-

stance is thicker than in the other parts of the spine, and the several processes stand off from each other distinct and clear; all which are provisions for a freer motion in the loins. The arch of the lumbar vertebra is wider than in the back, to admit the looser texture of the spinal marrow.

Spinal canal larger.

The body large and broad.

The BODY of a lumbar vertebra is particularly large, thick, and spongy, and its thin outer plate is perforated by many arteries going inwards to nourish this spongy substance of the bone. The length of the body is about an inch, and the intervertebral cartilage is very considerable; so that the vertebræ of the loins present to the eye, looking from within the body, a large, thick, and massy column, fit for supporting so great a weight.

The spinous process short.

The SPINOUS PROCESS is short, big, and strong. It runs horizontally and directly backwards from the arch of the spinal marrow. It is flattened, and about an inch in breadth; and it is commonly terminated by a lump or knob, indicating the great strength of the muscles and ligaments which belong to it, and the secure hold which they have.

Transverse process direct.

The TRANSVERSE PROCESS is longer and firmer than in the other vertebræ; it goes out laterally and horizontally, and is provided for the origins of powerful muscles. We find the spinous process divided into two unequal parts by a spine running from the inferior articulating process; in the same manner we see the transverse process divided by a ridge extending from the superior articulating process.

Articulating process perpendicular.

The ARTICULATING PROCESSES of the lumbar vertebræ stand so directly upwards and downwards, that the name of oblique processes cannot be applied here. They are tuberculated and strong, partaking of the peculiarity which marks the general form of those vertebræ of the loins.

Of the dorsal vertebræ.

Of the VERTEBRÆ OF THE BACK.—The character of the vertebræ of the back is directly opposite to that of the loins. The BODIES of the vertebræ are smaller, though still large enough to support the great weight of the trunk; but they are much deeper,

Body deep.

proportionably, than those of the loins, and their intervertebral substance is thin, for there is little motion here. The SPINOUS PROCESSES in the vertebræ of the back are very long and aquiline. They are broad at their basis, and very small or spinous at their further end; and in place of standing perpendicularly out from the body, they are so bent down, that they do not form a prominent nor unsightly spine, but are ranged almost in a perpendicular line, that is, laid over each other, like the scales of armour, the one above nearly touching the one below, by which the motions of these vertebræ are abridged; and the further to sustain the column, there is a groove on the under surface of the spinous process, which receives the superior edge of the one below. The TRANSVERSE PROCESSES are short and knobby: in place of standing free and clear out, like those of the loins, they stand obliquely backward, are trammelled and restricted from motion, by their connection with the ribs; for the ribs are not merely implanted upon the bodies of the dorsal vertebræ, but they are further attached firmly by ligaments, and by a regular joint, to the transverse process of each vertebra. Now the rib being fixed to the body of one vertebra, and to the transverse process of the vertebra below, the motions of the vertebræ are much curbed. We get another mark by which the dorsal vertebræ may be known: for each vertebra bears two impressions of the rib which was joined to it, one on the flat side of its body, and the other on the fore part of its transverse process. On the extremity of each of these transverse processes, a tubercle projects backward, giving advantage for the attachment of muscles. The articulating processes are so short, that they can hardly be described as distinct projections, and they stand out so directly from the transverse process, appearing as parts of it. The surfaces of these processes present more obliquity, and they are simpler in form, and smoother, than those of the loins.

Spinous process long, oblique, grooved.

Transverse processes directed backwards.

Impression on the transverse process.

Two impressions on the body.

Articulating processes.

More oblique.

The first and last dorsal vertebra distinguishable.

We may distinguish the first vertebra of the back, by its having the whole of the head of the rib impressed upon its side.

The 12th, or lowest dorsal vertebra, has also the entire head of the rib impressed upon it, and it has no articulating surface on the extremity of the transverse process.

Cervical vertebræ.

Their bodies small.

Of the VERTEBRÆ OF THE NECK.—The vertebræ of the neck depart still farther from the form of those of the loins. The BODY is very small in all the vertebræ of the neck. In the uppermost of the neck there is absolutely no body; and the next to that has not a body of the regular and common form. There is not in the vertebræ of the neck, as in those of the loins, a cup or hollow for receiving the intervertebral substance; but the surfaces of the body are flat or plain, and the articulating processes are oblique, and make, as it were, one articulation with the body; for the lower surface of the body being not hollow, but plain, and inclined forwards, and the articulating processes being also inclined backwards, and oblique, the two surfaces are opposed to each other; the one prevents the vertebræ from sliding forwards, and the other prevents it from sliding backwards, while a pretty free and general motion is allowed.

Articulating processes oblique.

Spinous process bifurcated, short, and horizontal.

The SPINOUS PROCESSES of the neck are short, and project directly backwards; they are for the insertion of many muscles, and therefore they are split, and have small tubercles on their extremities. This bifurcation of the spinous process is not absolutely peculiar to the cervical vertebræ; for sometimes, though rarely, the others are so: and it is only in the middle of the neck that even they are forked; for the first vertebra is a plain ring, with hardly any spinous process, because there are few muscles attached to it; and the process of the last vertebra of the neck is not bifurcated, so that it approaches to the nature of the dorsal vertebræ; the spinous process is long and aquiline, is depressed towards the back, and is so much longer than

Lower vertebra of the neck, the vertebra prominens.

the others, as to be distinguished by the name of VERTEBRA PROMINENS.

The TRANSVERSE PROCESSES of the neck are grooved and bifurcated, because there are a great many small muscles attached to them. But the most curious peculiarity of the transverse processes is, that each of them is perforated for the transmission of the great artery, which is named VERTEBRAL ARTERY, because it passes through these holes in the vertebræ which form altogether a bony canal for the artery. Transverse process bifurcated; perforated.

So that the character of these cervical vertebræ is, that they are calculated for much free motion; and the marks by which they are distinguished are, that the bodies are particularly small, the articulating processes oblique, with regard to their position, and almost plain on their surface. The spinous process, which is nearly wanting in the uppermost vertebræ, is short and forked in all the lower ones; the transverse process also is forked; and the transverse processes of all the vertebræ, except sometimes the first and last, are perforated near their extremities with the large hole of the vertebral artery. General character.

ATLAS AND VERTEBRA DENTATA.—But among these vertebræ of the neck, two are to be particularly distinguished, as of greater importance than all the rest; for though the five lower vertebræ of the neck be ossified and fixed, if but the two uppermost remain free, the head, and even the neck, seem to move with ease.

The first vertebra is named ATLAS, perhaps because the globe of the head is immediately placed upon it; the second is named DENTATA or axis, because it has an axis or tooth-like process upon which the first turns. Atlas.

The ATLAS has not the complete form of the other vertebræ of the neck, for its processes are scarcely distinguishable: it has no body, unless its two articulating processes are to be reckoned as a body: it is no more than a simple ring; it has hardly any spinous process; and its transverse process is long Wants the body. Spinous process short.

and perforated, but not forked. On the upper margin of the ring may be observed the mark of the ligament, which unites it to the margin of the occipital bone; and on the lower margin of the ring the mark of attachment of a similar ligament, which attaches it to the circle of the dentata. The BODY is entirely wanting: in its place, the vertebra has a flat surface looking backwards, which is smooth and polished for the rolling of the tooth-like process; there is also a sharp point rising perpendicularly upwards towards the occipital bone, and this point is held to the edge of the occipital hole by a strong ligament. The smooth mark of the tooth-like process is easily found; and upon either side of it, there projects a small point from the inner circle of the ring: these two points have a ligament extended betwixt them, called the transverse ligament, which, like a bridge, divides the ring into two openings; one the smaller, for lodging the tooth-like process, embracing it closely; the greater opening is for the spinal marrow: the ligament confines the tooth-like process; and when the ligament is burst by violence (as has happened), the tooth-like process, broken loose, presses upon the spinal marrow; the head, no longer supported by it, falls forward, and the patient dies. On the inside and lateral part of the circle, the origin of the lateral ligaments of the processus dentatus may also be observed.

Has a sharp point or process.

Articulating surface of the processus dentatus. Points of attachment of the transverse ligament.

Origin of the lateral ligament.

Articulating surfaces.

The ARTICULATING PROCESS may be considered as the body of this vertebra; for it is at once the only thick part, and the only articulating surface. This broad articulating substance is in the middle of each side of the ring: it has two smooth surfaces on each side; one looking upwards, by which it is joined to the occiput; and one looking directly downwards, by which it is joined to the second vertebra of the neck. The two upper articulating surfaces are oval, and slightly hollow to receive the occipital condyles: they are also oblique, for the inner margin of each dips downwards; the outer margin rises upwards, and the fore end of each oval is turned a little

The upper hollow oblique.

towards its fellow. Now, by the obliquity of the condyles, and this obliquity of the sockets which receive them, all rotatory motion is prevented, and the head performs, by its articulations with the first vertebra or atlas, only the nodding motions; and when it rolls, it carries the first vertebra along with it, moving round the tooth-like process of the dentatus. The articulation with the head is a hinge joint, in the strictest sense: it allows of no other motion than that backwards and forwards; the nodding motions are performed by the head upon the atlas, the rotatory motions are performed by the atlas moving along with the head, turning upon the tooth-like process of the dentatus as on a centre.

Forming with the condyles a hinge joint.

Now the upper articulating surfaces of the atlas are hollowed, to correspond with the condyles of the occipital bone, and to secure the articulation with the head; but the lower articulation, that with the vertebra dentata, being secured already by the tooth-like process of that bone, no other property is required in the lower articulating surfaces of the atlas, than that they should glide with perfect ease; for which purpose they are plain and smooth; they neither receive nor are received into the dentata by any hollow, but lie flat upon the surfaces of that bone. It is also evident, that since the office of the atlas is to turn along with the head, it could not be fixed to the vertebra dentata in the common way, by a body and by intervertebral substance; and since the atlas attached to the head moves along with it, turning as upon an axis, it must have no SPINOUS PROCESS; for the projection of a spinous process must have prevented its turning upon the dentatus, and would even have hindered, in some degree, the nodding of the head; therefore the atlas has a simple ring behind, and has only a small knob or button where the spinous process should be, which is somewhat irregularly notched. The TRANSVERSE PROCESS is not forked, but it is perforated with a large hole for the vertebral artery; and the artery, to get

The lower surface plain, smooth.

Turning on the dentata.

No spinous process.

Transverse process perforated for the artery.

into the skull, makes a wide turn, lying flat upon the bone, by which there is a slight hollow or impression of the artery, which makes the ring of the vertebra exceedingly thin. Sometimes, instead of the groove for the artery, there is a perforation in the ring.

Impression of the artery.

But the form of the vertebra dentata best explains these peculiarities of the atlas, and this turning of the head.

Dentata, general form.

The VERTEBRA DENTATA, ODONTOIDES, or AXIS, is so named from its projecting point, which is the chief characteristic of this bone. When the dentata is placed upright before us, we observe, 1. That it is most remarkably conical, rising all the way upwards by a gradual slope to the point of its tooth-like process. 2. That the ring of the vertebra is very deep, that is, very thick in its substance, and that the opening of the ring for transmitting the spinal marrow is of a triangular form. 3. That its spinous process, though short and thick, yet projects beyond the level of the three spinous processes immediately below it; and that it is turned much downwards, so as not to interfere, in any degree, with the rotation of the atlas. 4. That its tooth-like process, from which the bone is named, is very large, about half an inch in length; very thick, like the little finger; that it is pointed; and that from this rough point a strong ligament goes upwards, by which the tooth is tied to the great hole of the occipital bone. We also observe a neck or collar, or smaller part, near the root of the tooth-like process, where it is grasped by the transverse ligament of the atlas; while the point of the process swells out a little above. We find this neck particularly smooth; for it is indeed upon this collar that the head continually turns. And we see on each side of this tooth-like process a broad and flat articulating surface. These articulating surfaces are placed like shoulders; and the atlas, being threaded by the tooth-like process of the dentata, is set flat down upon the

Spinous process short, and strong.

Its tooth-like process.

Neck of the process.

Articulating surfaces.

high shoulders of this bone, and there it turns and performs all the rotatory motions of the head.

On the side of the tooth-like process we may observe the roughness for the insertion of the lateral ligaments, and its point is irregular where it is grasped by the perpendicular ligament which comes down from the occipital bone. Insertion of the lateral ligaments.

We may observe, that while the superior articulating processes are horizontal, answering the purpose of a body, the lower surface of this vertebra is in all respects like the other vertebræ of the neck. Articulating surface horizontal.

Of the SPINE generally.

All the vertebræ conjoined make a large canal of a triangular or roundish form, in which the spinal marrow lies, giving off and distributing its nerves to the neck, arms, and legs; and the whole course of the canal is rendered safe for the marrow, and very smooth by lining membranes, the outermost of which is of a leather-like strength and thickness, and serves this double purpose; that it is at once a hollow ligament to the whole length of the spine upon which the bones are threaded, and by which each individual bone is tied and fixed to the next. Within this there is the proper vagina or sheath which contains the spinal marrow, and which is bedewed on its internal surface with a thin exudation, keeping the sheath moist and soft, and making the enclosed marrow lie easy and safe.

All down the spine, this spinal medulla is giving off its nerves: one nerve passes from it at the interstice of each vertebra; so that there are twenty-five nerves of the spine, or rather fifty nerves, twenty-five being given towards each side; these nerves pass each through an opening or small hole in the general sheath; there they pass through the interstice of each vertebra; so that there is no hole in the bone required, but the nerve escapes by going under the articulating process. This, indeed, is

converted into something like a hole, when the two contiguous vertebræ are joined to each other.

The bodies of the vertebræ are somewhat peculiar in structure, being light and spongy bones, covered with a thin cortex: and it is from these circumstances that they are very liable to scrofulous caries.

The **INTERVERTEBRAL SUBSTANCE.**— The intervertebral substance is that which is interposed betwixt the bodies of two adjoining vertebræ, and which is (at least in the loins) nearly equal in thickness to the body of the vertebra to which it belongs. We give it this undefined name, because there is nothing in the human system to which it is entirely similar; for it is not ligament, nor is it cartilage, but it is commonly defined to be something of an intermediate nature: it is a soft and pliant substance, which is curiously folded and returned upon itself, like a rolled bandage with folds, gradually softer towards the centre, and with the rolled edges as if cut obliquely into a sort of convex. The cut edges are thus turned towards the surface of the vertebra, to which each intervertebral substance belongs: it adheres to the face of each vertebra, and it is confined by a strong ligament all round; and this substance, though it still keeps its hold on each of the two vertebræ to which it belongs, though it permits no true motion of one bone on another, but only by twisting of its substance, yields, nevertheless, easily to whichever side we incline, and it returns in a moment to its place by a very powerful resilience. This perfect elasticity is the chief character and virtue of this intervertebral substance, whose properties indeed are best explained by its uses; for, in the bendings of the body, it yields in a very considerable degree, and rises on the moment that the weight or the force of the muscles is removed. In leaping, in shocks, or in falls, its elasticity prevents any harm to the spine, while other less im-

portant joints are luxated and destroyed; and it gives to the whole column that fine elasticity which guards the head from sudden shocks, and the brain from vibration.

Since pressure, in length of years, shortens the fore part of the column of the spine, and makes the body stoop, any undue inclination to either side will cause distortion: the substance yields on one side, and rises on the other; and at last the same change happens in the bones also, and the distortion is fixed, and not to be changed but with great difficulty and by exercises continued for a long time: this distortion is peculiarly apt to happen with children whose bones are growing, and whose gristles and intervertebral substances are peculiarly soft; so that a tumour on the head or jaw, which makes a boy carry his head on one side, or constant stooping, such as is used by a girl in working at the tambour, or the carrying of a weakly child always on one arm by a negligent or awkward nurse, will cause in time a distortion.

We are now qualified to understand the motions of the vertebræ, and to trace the degree of motion in each individual class. The degrees of motion vary with the forms of the vertebræ, in each part of the spine: the motion is freest in the neck, more limited in the loins, and in the back (the middle part of the spine) scarcely any motion is allowed: the head performs all the nodding motions upon the first vertebra of the neck: the first vertebra of the neck performs again all the quick and short turnings of the head, by moving upon the dentatus: all the lower vertebræ of the neck are also tolerably free, and favour these motions by a degree of turning; and all the bendings of the neck are performed by them. The dorsal vertebræ are the most limited in their movements, bending chiefly forwards by the yielding of their intervertebral substance. The vertebræ of the loins again move largely, for their intervertebral substance is deep, and their processes less entangled. To perform these motions, each vertebra

has two distinct joints, as different in office as in form: first, each vertebra is fixed to those above and below by the intervertebral substance, which adheres so to each that there is no true motion; there is no turning of any one vertebra upon the next; but the elasticity of the intervertebral substance allows the bones to move a little, so that there is a general twisting and gentle bending of the whole spine. The second joint is of the common nature with the other joints of the body, for the articulating processes are faced with cartilage, surrounded with a capsule, and lubricated with synovia. And I conceive this to be the intention of the articulating processes being produced to such a length, that they may lap over each other to prevent luxations of the spine; and they must, of course, have these small joints, that they may yield to this general bending of the spine.*

RIBS AND STERNUM.

Of the ribs. — The ribs, whose office it is to give form to the thorax, and to cover and defend the lungs, also assist in breathing; for they are joined to the vertebræ by regular hinges, which allow of short motions, and to the sternum by cartilages, which yield to the motion of the ribs, and return again when the muscles cease to act.

Each rib, then, is characterised by these material parts: a great length of bone, at one end of which there is a head for articulation with the vertebræ, and a shoulder or knob for articulation with its transverse process; at the other end there is a point, with a socket for receiving its cartilage, and a cartilage joined to it, which is implanted into a similar socket in the side of the sternum, so as to complete the form of the chest.

* See farther of the Spine, in the Review of the Skeleton

The ribs are twelve in number, according to the number of the vertebræ in the back, of which seven are named true ribs, because their cartilages join directly with the sternum, and these are the preservers, the *custodes*, as protecting the heart; and five are named false ribs, because their cartilages are not separately nor directly implanted into the sternum, but are joined one with another; the cartilage of the lower rib being joined and lost in that of the rib above, so that all the lower ribs run into one greater cartilage. But there is still another distinction, viz. that the last rib, and commonly also the rib above, are not at all implanted in the sternum, but are loosely connected only with the muscles of the abdomen, whence they are named the loose or floating ribs.

Classification of the ribs; Seven true. Five false. Two floating ribs.

The ribs are, in general, of a flattened form, their flat sides being turned smooth towards the lungs. But this flatness of the rib is not regular; it is contorted, as if the soft rib had been seized by either end, and twisted betwixt the hands: the meaning of which is, to accommodate the flatness of the rib to the form which the thorax assumes in all its degrees of elevation; for when the rib rises, and during its rising through all the degrees of elevation, it still keeps its flat side towards the lungs. Though of a flattened form, the rib is a little rounded at its upper edge, is sharp and cutting at its lower edge; and its lower edge seems double; for there is a groove, which in some measure gives security to the intercostal artery and nerve.

Their form flat. Twisted. Upper edge rounded. A groove on the lower edge.

On each rib we find the following parts: 1. The HEAD, or round knob, by which it is joined to the spine. The head of each rib has indeed but a small articulating surface; but that smooth surface is double, or looks two ways. For the head of the rib is not implanted into the side of one vertebra, it is rather implanted into the interstice betwixt two vertebræ; the head touches both vertebræ; all the vertebræ, except the first and last,

The head having two articulating surfaces.

bear the mark of two ribs, one above, and one below. The mark of the rib is on the edge of either vertebra, and the socket may be said to lie in the intervertebral substance betwixt them.

Cervix. 2. The NECK of the rib is a smaller part, immediately before the head. Here the rib is particularly small and round.

Tubercle. 3. About an inch from the head, there is a second rising, or bump, the articulating surface by which it touches and turns upon the transverse process of the vertebra below. These two articulations have each a distinct capsule or bag: each is a very regular joint; and the degree of motion of the rib, and direction in which it moves, may be easily calculated from the manner in which it is jointed with the spine; for the two articulating surfaces of the rib are on its back part: the back of the rib is simply laid upon the side of the spine; the joints, with the body of the vertebra, and with its transverse process, are in one line and form as if but one joint; so that the rib being fixed obliquely, and at one end only, that end continues firm, except in turning upon its axis: the two heads roll upon the body of the vertebræ, and upon the transverse process; and so its upper end continues fixed, while its lower end rises or falls; and as the motion is in a circle, the head being the central point, moves but little, while the lower end of the rib has the widest range.

Articulating with the transverse process.

A second tubercle. 4. Just above the second articulating surface there is a second turbercle, which has nothing to do with the joints, but is intended merely for the attachment of the ligaments and muscles from the spine which suspend and move the rib, and for the attachment of the anterior slips of the longissimus dorsi muscle.

The angle. 5. The angle of the rib is often mentioned, being a common mark for the place of surgical operations. There is a flatness of the thorax behind, forming the breadth of the back; the sharpness where this flatness begins to turn into the round-

ness of the chest is formed by the angles of the ribs. Each rib is round in the place of its head, neck, and turbercles: it grows flatter a little, as it approaches the angle: but it is not completely flattened till it has turned the angle which is the proper boundary betwixt the round and the flat parts of the rib; into these angles of the ribs the sacro-lumbalis is inserted. This anatomy of the ribs is sufficiently simple, but it is not equally easy to observe how it bears on the practice of surgery. It is in some degree useful in the more advanced parts of anatomy, to remember the names; and it is necessary, even in speaking the common language of surgeons, to know these parts, viz. the head of the rib; the turbercle, or second articulating surface; the angle, or turning forward of the rib; the upper round, and the lower sharp edge; and especially to remember the place and the dangers of the intercostal artery. It is, however, more important to consider the connections of parts; as the seat of the artery, the manner in which the ribs are lined with the pleura, and their nearness to the surface of the lungs. The ribs increase in the obliquity of their position from the highest to the lowest, and their anterior extremities expand, and are more distant from each other. There are some peculiarities in individual ribs, the chief of which are these: the length of the rib is increasing from the first to the seventh, but again decreases from the seventh to the twelfth; the curve of the ribs gradually decreases from the first to the last, the first being exceedingly short and circular, the lower ones longer, and almost right lined, making a small portion or segment of a large circle; so that the thorax is altogether of a conical shape, the upper opening so small, as just to permit the trachea, œsophagus, and great vessels to pass; the lower opening so large, that it equals the diameter of the abdomen: the first rib is consequently very short; it is thick, strong, and of a flattened form; of which flatness one face

Recapitulation of the anatomy of the rib.

Peculiarities of individual ribs.

looks upwards, and another downwards, and the great axillary artery and vein lie upon its flat upper surface. We do not see any groove on the lower surface for the intercostal artery. It is also particularly circular, making more than half a circle from its head to the extremity where it joins the sternum; it has, of course, no angle, and wants the distorted twisting of the other ribs: the second rib is also round, like the first rib. The eleventh and twelfth, or the floating ribs, are exceedingly small and delicate, and their cartilage terminates in an acute point, unconnected with the sternum: and, lastly, the heads of the first, and of the twelfth ribs, are rounder than any of the others; for these two have their heads implanted into the flat side of one vertebra only, while all the others have theirs implanted betwixt the bodies of two vertebræ. And there is this further difference, that in the eleventh and twelfth ribs there are no tubercles for the articulation with the transverse processes. The cartilages of the ribs become longer as they descend and approach nearer to each other; they complete the form of the thorax, and form all the lunated edge of that cavity; and it is from this cartilaginous circle that the great muscle of the diaphragm has its chief origin, forming the partition betwixt the thorax and the abdomen. The farther end of each rib swells out thick and spongy, and has a small socket for lodging the cartilage; for these cartilages are not joined, like the intervertebral substances, with their bones: but there is a sort of joint, very little moveable indeed, but still having a rude socket, and a strong capsular ligament, and capable of luxation by falls and blows; the implantations into the sternum are evidently by fair round sockets, which are easily distinguished upon the two edges of that bone. These cartilages may be enumerated thus: The cartilages of the first and second ribs descend to touch the sternum. The cartilage of the third rib is direct. The cartilages of the fourth, fifth,

Socket in the anterior extremity of the rib, and of the cartilage.

and sixth ribs rise upwards, in proportion to their distance from this central one. The first five ribs have independent cartilages. The eighth, ninth, and tenth ribs run their cartilages into the cartilage of the seventh rib. And the eleventh and twelfth ribs have their cartilages small, unconnected, and floating loose.

By the motion of the ribs, the thorax is alternately dilated and diminished in capacity, the lungs thereby having their play. A rib has two motions: 1. Its sternal end rises and falls, the centre of motion being in the articulation with the spine. 2. It moves on its own axis; a line drawn through the two extremities is the centre of this motion. The former motion enlarges and diminishes the diameter of the thorax, from the spine to the sternum; this enlarges the lateral diameter of the thorax. The importance of attending to the motion of the ribs is obvious in practice; for when the rib is broken, the ends jar and rub against each other, in consequence of the anterior extremity moving through a greater space than the posterior; and the business of the surgeon is to interrupt this. Besides, the fracture of the rib, most commonly of little consequence, is sometimes attended with the most serious symptoms, and even death; for if the fractured extremity punctures the membrane of the lungs, the air is drawn into the cavity of the chest, and from thence is pressed into the cellular substance, and the man is blown up in a prodigious degree. Motion of the ribs.

THE STERNUM. — The sternum is that long and squared bone, which lies on the fore part of the breast over the heart, and which being joined by the cartilages of the ribs, completes the cavity of the chest; it is for completing the thorax, and defending the heart, for a medium of attachment to the ribs, and for a fulcrum or point, on which the clavicles may roll. Sternum.

We find the sternum consisting in the child of eight distinct pieces, which run together in the In the child eight pieces.

progress of life, and which, in old age, are firmly united into one; but in all the middle stage of life, we find three pieces in the sternum, two of which are properly bone, the third remains a cartilage till very late in life, and is named the ensiform cartilage, from its sword-like point.

In middle age three.

It is found to have eight pieces, even in the child of six years old: some years after, it has but five or six; and the salient white lines which traverse the bone, mark where the intermediate cartilages have once been.

Triangular portion.

1. The upper piece of the sternum is very large, roundish, or rather triangular, resembling the form of the heart on playing-cards: it is about two inches in length, and an inch and a half in breadth; and these marks are easily observed. The APEX, or point of the triangle, is pointed downwards, to meet the second bone of the sternum. The BASE OF THE TRIANGLE, which is uppermost, towards the root of the throat seems a little hollowed, for the trachea passing behind it. On each upper corner, it has a large articulating hollow, into which the ends of the collar bones are received (for this bone is the steady fulcrum upon which they roll.) A little lower than this, and upon its side, is the socket for receiving the short cartilage of the first rib; and the second rib is implanted in the interstice betwixt the first and second bone of the sternum; so that one half of the socket for its cartilage is found in the lower part of this bone, and the other half in the upper end of the next.

Apex.

Base upwards, hollowed for the throat.

Articulates with the clavicle.

Socket for the first rib.

Part of the second rib touches this.

2. The second piece of the sternum is of a squared form, very long and flat, and composing the chief length of the sternum: for the first piece receives only the cartilage of the first rib, and one half of the second; but this long piece receives, on each side or edge of it, the cartilages of eight ribs; and as three of the lower cartilages are run into one, there are but five sockets or marks. The sockets for receiving the cartilages

Central portion oblong. Five pits for the attachment of eight ribs.

of the ribs are on the edges of the sternum; they are very deep in the firm substance of the bone, and large enough to receive the point of the finger with ease: and whoever compares the size and deepness of these sockets with the round heads of the cartilages which enter into them, will no more doubt of distinct joints here than of the distinct articulation of the vertebræ with each other.

The third piece.

3. This is, in truth, the whole of the bony sternum; and what is reckoned the third piece, is a cartilage merely, and continues so down to extreme old age.

Cartilago ensiformis.

This cartilage, which ekes out, and lengthens the sternum, and which is pointed like a sword, is thence named CARTILAGO MUCRONATA, the pointed cartilage; or CARTILAGO ENSIFORMIS, or XIPHOIDES, the sword-like cartilage. One half of the pit for the attachment of the seventh rib is on this portion. This cartilaginous point, extending downwards over the belly, gives a sure origin and greater power to the muscles of the abdomen, and that without embarrassing the motions of the body;

Sometimes forked.

but this cartilage, which is commonly short and single-pointed, is sometimes forked, sometimes bent inwards, so (it has been thought) as to occasion sickness and pain; and once was produced to such a length, as to reach the navel, and ossified at the same time, so as to hinder the bending of the body, and occasion much distress.

Surgical remarks.

The sternum and the ribs, and all the chest, stand so much exposed, that did we not naturally guard them with the hands, fractures must be very frequent; but indeed when they are broken, and beaten in, they hurt the heart or lungs, and not unfrequently the most dreadful consequences ensue. The sternum is, like the body of a vertebra, spongy and covered with a thin cortex of bone, and sheathed with ligaments; and being exposed, it is very subject to scrofulous inflammation.

The fracture of the sternum is a most serious accident; for when there is not death in conse-

quence of the injury of the heart, there is a grating and rubbing of the broken surfaces: for the lower extremity of the sternum is carried forward in inspiration; and therefore, when there is a fracture, the lower part moves upon the upper part, and if not restrained, it will cause inflammation and suppuration beneath.

PELVIS.

To give a steady bearing to the trunk, and to connect it with the lower extremities by a sure and firm joining, the pelvis is interposed; which is a circle of large and firm bones, standing as an arch betwixt the lower extremities and the trunk. Its arch is wide and strong, so as to give a firm bearing to the body; its individual bones are large, so as to give a deep and sure socket for the implantation of the thigh bone; its motions are free and large, bearing the trunk above and rolling upon the thigh bones below; and it is so truly the centre of all the great motions of the body, that when we believe the motion to be in the higher parts of the spine, it is either the last vertebra of the loins bending upon the top of the pelvis, or the pelvis itself rolling upon the head of the thigh bones.

Pelvis consisting in the child of many pieces, in the adult of four.

The PELVIS is named from its resembling a basin in its form; or, perhaps, from its office of containing the urinary bladder, rectum, vagina, and womb: it consists in the child of many pieces, but in the adult it is formed of three large bones and a smaller one; viz. the sacrum, and ossa innominata, and os coccygis.

The sacrum.

OS SACRUM. — The names, os sacrum, os basilare, &c. seem to relate rather to its greater size than to its ever having been offered in sacrifice. This bone, with its appendix, the os coccygis, is called the false spine, or the column of the false vertebræ: authors making this distinction, that the true vertebræ are those of the back, neck, and loins, which possess

The false vertebræ.

motion, a column which grows gradually smaller upwards; the false vertebræ are those of the sacrum and coccyx, which are conical, with the apex or point downwards, and the base, viz. the top of the sacrum, turned upwards to meet the true spine, and which have no motion like the pieces of the spine.

The bones of which the sacrum is composed had originally the form of distinct, small vertebræ. These distinctions are lost in the adult, or are recollected only by the marks of former lines; for the original vertebræ are now united into one large and firm bone.

The sacrum originally distinct pieces or vertebræ.

We can recognize the original vertebræ, even in the adult bone; for we find it regularly perforated with holes, for the transmission of the spinal nerves: we find these holes regularly disposed in pairs: we see a distinct white and rising line, which crosses the bone, in the interstice of each of the original vertebræ, and marks the place where the cartilage once was; and by these lines, being five in number, with generally five pair of holes, we know this bone to have consisted once of five pieces, which are now joined into one. The remains of former processes can also be distinguished, and the back of the bone is rough and irregular from the projection of the spinous processes.

Which we recognise in the adult bone.

The os sacrum, thus composed, is among the lightest bones of the human body, with the most spongy substance, and the thinnest tables; but then it is a bone the best cemented, and confirmed by strong ligaments, and the best covered by thick and cushion-like muscles. The os sacrum is of a triangular shape; the base of the triangle turned upwards to receive the spine; its inner surface is smooth, to permit the head of the child in labour to glide easily along; and its outer surface is irregular and rough, with the spines of former vertebræ, giving rise to the great glutæi muscles, (which form the contour of the hip,) and to the strong muscles of the back and loins, the longissimus dorsi

Substance spongy.

Form triangular.

Concave within.

Irregular on the back part.

and sacro-lumbalis, which are for raising the spine and sustaining the body.

Its cavity. Triangular. It has in it a triangular cavity under the arch of its spinous processes; which cavity is continued from the canal in the vertebræ of the spine; and this cavity of the sacrum contains the continuation and the end of the spinal marrow, which being, before it descends to this place, divided into a great many thread-like nerves, has altogether the form of a horse's tail, and is therefore named cauda equina.

Foramina. From this triangular cavity the nerves of the cauda equina go out by four, sometimes five, great holes on the fore part of the sacrum, holes large enough to receive the point of the finger: grooves are seen running from these holes, for the passage of the sacral nerves. The first three nerves of the sacrum joining with the last two nerves of the loins, form the sacrosciatic nerve, the largest in the body, which goes downward to the leg, while the two lower nerves of the sacrum supply the contents of the pelvis alone.

The back of the sacrum is also perforated with four holes, whose size is nearly equal to those on its fore part: these transmit no great vessel nor nerve, and seem to be merely for diminishing the weight and substance of the bone.

Base articulated with the vertebra. All the edges of the sacrum form articulating points, by which it is joined to other bones. The base, or upper part of the sacrum, receives the last vertebra of the loins on a large broad surface, which makes a very moveable joint; and, indeed, the joining of the last true vertebra with the top of the sacrum, is a point where there is more motion than in the higher parts of the spine. Articulating processes. The sacrum has two articulating surfaces, which stand perpendicular, and correspond with those of the lower lumbar vertebra. Apex with the os coccygis. The apex, or point of the sacrum, has the os coccygis joined to it; which joining is moveable till the age of twenty in men, and till the age of forty-five in women; and the meaning of its con-

tinuing longer moveable in women is very plain, since the lower point of the coccyx in women is felt yielding in the time of labour, so as to enlarge greatly the lower opening of the pelvis. The sides of the os sacrum form a broad, rough, and deeply indented surface, which receives the like rough surface of the haunch bones, by that sort of union which is called synchondrosis: but here the surfaces are so rough, and the cartilage so thin, that it resembles more nearly a suture; and by the help of the strong ligaments, and of the large muscles which arise in common from either bone, makes a joining absolutely immoveable, except by such violent force as is in the end fatal.

Lateral articulating or scabrous surface.

Thus the original state of this bone is easily recognized and traced by many marks; it stands in a conspicuous place of the pelvis, and its chief office is to support the trunk: to which we may add, that it defends the cauda equina, transmits its great nerves, forms chiefly the cavity of the pelvis, and that it is along the hollow of this bone that the accoucheur calculates the progress of the child's head in labour.

The OS COCCYGIS, so named from its resemblance to the beak of a cuckoo, is a small appendage to the point of the sacrum, terminating this inverted column with an acute point, and found in very different conditions in the several stages of life. In the child it is merely cartilage, and we can find no point of bone; during youth it is ossifying into distinct bones, which continue moveable upon each other till manhood; then the separate bones gradually unite with each other, so as to form one conical bone, with bulgings and marks of the pieces of which it was originally composed; but still the last bone continues to move upon the joint of the sacrum, till, in advanced years, it is at last firmly united, later in women than in men, with whom it is often fixed at twenty or twenty-five. The first bone is flat, with two transverse processes; the others become gradually of a roundish form, convex without, and concave

Os coccygis an appendix to the sacrum; in the child cartilage.

Moves on the sacrum.

In advanced years united to it.

It has no cavity.

inwards, forming, with the sacrum, the lowest part of the pelvis behind. It has no distinct holes, but the last sacral hole is frequently completed by a groove on the upper surface of the first bone; it has no communication with the spinal canal, but points forwards to support the lower part of the rectum. The prolongation of this appendix to the spine by a succession of additional bones, forms the tail in quadrupeds; while, in man, the coccyx is turned in to support the parts contained in the pelvis, and to afford an elastic extremity to the spine, on which, in some measure, we rest in sitting: in women it continues so moveable as to recede in time of labour, allowing the child's head to pass. This bone is apt to be dislocated by our falling with the breech on a projecting corner, or, more ignominiously, by kicks in the same place. When dislocated, it gives rise to very considerable distress, and to disorder of the function of the rectum and neck of the bladder.

Os innominatum.

The OSSA INNOMINATA are the two great irregular bones forming the sides of the pelvis, which have a form so difficult to explain by one name, that they are called ossa innominata, the nameless bones. But these bones having been in the child formed in distinct and separate pieces, these pieces retain their original names, though united into one great bone: we continue to explain them as distinct bones, by the names of os ilium, os ischium, and os pubis.

Divided into three.

The OS ILIUM, the haunch-bone, is that broad and expanded bone on which lie the strong muscles of the hip, and which forms the rounding of the haunch. The OS ISCHIUM, the hip-bone, the lowest point of the pelvis, that on which we rest in sitting. The OS PUBIS, or share-bone, on which the private parts are placed. All these bones are divided in the child; they are united in the very centre of the socket for the thigh-bone; and we find in the child a thick cartilage in the centre of the socket, and a prominent ridge of bone in the adult; which ridge, far from incommoding the articulation with the thigh-bone, gives a firmer hold to the cartilage which

lines that cavity, and is the point into which a strong ligament from the head of the thigh-bone is implanted.

The OS ILIUM, or haunch-bone, is named from its forming the flank. It is the largest part of the os innominatum. It rises upwards from the pelvis in a broad expanded wing, which forms the lower part of the cavity of the abdomen, and supports the chief weight of the impregnated womb (for the womb commonly inclines to one side). The os ilium is covered with the great muscles that move the thighs, and to its edge are fixed those broad flat muscles which form the walls of the abdomen. This flat upper part is named the ALA, or WING; while the lower, or rounder part, is named the BODY of the bone, where it enters into the socket, and meets the other bones.

Os ilii.

The ALA, or flat expanded wing, has many parts, which must be well remembered, to understand the muscles which arise from them. 1. The whole circle of this wing is tipt with a ridge of firmer bone, which encircles the whole. This is a circular cartilage in the child, distinct from the bone, and is ossified and fixed only at riper years. All this ridgy circle is called the spine, and is the origin for several muscles. The external oblique muscle of the abdomen is inserted into the outer edge or labrum, and from this margin the gluteus maximus and medius arise. The internal oblique arises from the middle rough line, and the transversalis from the inner edge of the spine. 2. The two ends of this spine are abrupt, and the points formed upon it are consequently named spinous processes, of which there are two at its fore and two at its back end. The two POSTERIOR SPINOUS PROCESSES are close by each other, and are merely two rough projecting points near the rough surface by which the os ilium is joined to the os sacrum: they jut out behind the articulation, to make it firm and sure; and their chief uses seem to be the giving a firm hold to the strong ligaments which bind this joint. Where the spine terminates

Ala.

Spina.

Spinous processes.

Posterior, superior, and inferior.

in this process the great muscle of the hip, the gluteus maximus, takes its rise. 3. The two anterior spinous processes are more distinct, and more important marks; for the ANTERIOR SUPERIOR SPINOUS PROCESS is the abrupt ending of the spine, or circle of the ilium, with a swelling out: from which jutting point the sartorious muscle, the longest, and amongst the most beautiful in the human body, goes obliquely across the thigh, like a strap, down to the knee; another, which is called the tensor vaginæ femoris, also arises here; and from this point departs the ligament, which, passing from the os ilium to the pubis, or fore point of the pelvis, is called Poupart's ligament. The LOWER ANTERIOR spinous process is a small bump, or little swelling, about an inch under the first one, which gives rise to the rectus femoris muscle, or straight muscle of the thigh, which lies along its fore part; and upon the inside of the process there is a depression lodging the iliacus internus and psoas magnus.

Anterior superior.

Anterior inferior.

Dorsum.

The back, or DORSUM of the os ilium, is covered with the three great glutæi muscles. We remark in a strong bone a semicircular ridge, which runs from the upper part of the anterior inferior spinous process to the lower part of the notch, and which marks the place of origin of the gluteus minimus. The inner surface is hollowed, so as to be called the cup or hollow, or sometimes the venter.

Cup.

Articulation with the sacrum.

Scabrous surface.

This bone (the os ilium) has a broad rough surface, by which it is connected with the os sacrum at its side; the very form of which declares the nature of this joining, and is sufficient argument and proof that the joinings of the pelvis do not move.

Linea innominata.

The acute line, which is named LINEA INNOMINATA, is seen upon the internal surface of the bone, dividing the ala, or wing, from that part which forms the true pelvis. This line composes part of the brim of the pelvis, distinguishes the cavity of the pelvis from the cavity of the abdomen, and marks the circle into which the head of the child descends

at the commencement of labour. This bone enters into the composition of the socket for the thigh-bone, in a manner to be presently explained. Acetabulum.

In many parts of the bone we see holes for transmitting vessels; we find one particularly large in the cup.

The OS ISCHIUM, or hip-bone, is placed perpendicularly under the os ilium, and is the lowest point of the pelvis upon which we sit. It forms the largest share of the socket, whence the socket is sometimes named acetabulum ischii, as peculiarly belonging to this bone. The bump or round swelling upon which we rest is named the tuber ischii; and the smaller part which extends upwards to meet the os pubis, is named the ramus, or branch, which meets a similar branch of that bone to form the thyroid hole. Os ischii.

The BODY is the uppermost and thicker part of the bone which helps in forming the socket; and among the three bones, this one forms the largest share of it; nearly one half. From the body, a sharp-pointed process, named SPINOUS PROCESS of the ischium, is projected backwards; which, pointing towards the lower end of the sacrum, receives the uppermost of two long ligaments, which, from their passing betwixt the ischium and sacrum, are named sacro-sciatic: by this ligament a semi-circle of the os ilium, just below the joining of the ilium with the sacrum, is completed into a large round hole; which is in like manner named the sacro-sciatic hole, and gives passage to the pyramidalis muscles, and to the great nerve of the lower extremity, named the great sacro-sciatic nerve. Body. Spinous process. Notch of ilium.

From the TUBER, or round knob, being the point upon which we rest, this bone has been often named OS SEDENTARIUM. The bump is a little flattened where we sit upon it. It is the mark by which the lithotomist directs his incision, cutting exactly in the middle betwixt the anus and this point of bone. It is remarkable as being the point towards which the posterior or lower sacro-sciatic ligament extends, and as a point which gives rise to several of the Tuber.

strong muscles on the back of the thigh, and especially to those which form the hamstrings, semitendinosus, semi-membranosus, and long head of the biceps cruris.

Between the scabrous surface on the tuber, and the edge of the acetabulum, there is a smooth surface, rather depressed, which is called the CERVIX. It is covered with a cartilage which allows the tendon of the obturator internus to move easily.

Cervix.

Ramus.

The RAMUS, or branch, rises obliquely upwards and forwards, to join a like branch of the pubis. This branch, or arm, as it is called, is flat, and its edges are turned a little forwards and backwards; so that one edge forms the arch of the pubis, while the other edge forms the margin of the thyroid hole.

Os Pubis.

The OS PUBIS, or SHARE-BONE, is the last and smallest piece of the os innominatum, and is named from the mons veneris being placed upon it, and its hair being a mark of puberty. It forms the upper, or fore part of the pelvis, and completes the brim; and, like the ischium, it also is divided into three parts, viz. the BODY, ANGLE, and RAMUS.

Body.

The BODY of the os pubis is thick and strong, and forms about one fifth of the socket for the thigh-bone. It is not only the smallest, but the shallowest part of the socket. The bone grows smaller, as it advances towards its angle; it again grows broad and flat, and the two bones meet with rough surfaces, but with two cartilages interposed. Over the middle of this bone, two great muscles, the iliac and psoas muscles, pass out of the pelvis to the thigh; and where they run under the ligament of the thigh, the pubis is very smooth. On the angle or crest there is a process which is frequently called tuberous angle: from this process there are two ridges traced; one goes to meet the line on the ilium, forming the brim of the pelvis, and forms the linea ileo pectinea, or linea innominata; the other goes down towards the edge of the acetabulum: between these two ridges there is a flat surface giving origin to the pectineus. The RAMUS, or

Crest.

Linea ileo pectinea.

Ramus.

branch, is that more slender part of the pubis, which, joining with the branch of the ischium, forms with it the arch of the pubis, and the edge of the thyroid hole. Just under the body of the bone, there is a groove, which forms that part of the thyroid hole which transmits the obturator nerve and artery. Groove of the os pubis

This completes the strict anatomy of the pelvis; but when we consider the whole, it is further necessary to repeat, in short definitions, certain points which are oftener mentioned as marks of other parts.

The PROMONTORY of the sacrum is the projection formed by the lowest vertebra of the loins, and the upper point of that bone. The HOLLOW of the sacrum is all that smooth inner surface which gives out the great nerves for the legs and pelvis. The LESSER ANGLE, in distinction from the greater angle or promontory of the sacrum, is a short turn in the bone near where it is joined with the os coccygis. The CREST of the PUBIS is a sharper ridge or edge of the bone over the joining or symphysis pubis. The POSTERIOR SYMPHYSIS of the pelvis is the joining of the sacrum with the ilium, while the symphysis pubis is distinguished by the name of ANTERIOR SYMPHYSIS of the pelvis. The SPINE, the TUBER, and the RAMUS of the ischium are sufficiently explained. The ALA, or wing, the SPINE, the SPINOUS PROCESSES, and the LINEA INNOMINATA of the ilium, have been already sufficiently explained. The ACETABULUM, so named from its resemblance to a measure which the ancients used for vinegar, is the hollow or socket for the thigh-bone, composed of the ilium, ischium, and pubis; the ridge in its centre shows the place of its original cartilage, and points out what proportion belongs to each bone; that it is made, two fifths by the os ilium, twofifths by the os ischium, and one fifth only by the os pubis; but the ischium has the greatest share; the ischium forming more than two fifths, and the ilium less. On the lower part of the margin there is a deficiency of bone; Promontory of sacrum. Hollow. Lesser angle. Crest of pubis. Symphyses. Acetabulum ischii.

which, however, is made up by a ligament, and yet not so perfectly, but that dislocation of the head of the femur sometimes takes place in this direction.

Brim of the pelvis. The BRIM of the PELVIS is that oval ring which parts the cavity of the pelvis from the cavity of the abdomen; it is formed by a continued and prominent line along the upper part of the sacrum, the middle of the ilium, and the upper part or crest of the pubis. This circle of the brim supports the impregnated womb, keeps it up against the pressure of the labour pains; and sometimes this line has been "as sharp "as a paper-folder, and has cut across the lower "segment of the womb;" and so, by separating the womb from the vagina, has rendered the delivery impossible; and the child escaping into the abdomen among the intestines, the woman has died.* The OUTLET of the PELVIS is the lower circle again, composed by the arch of the pubis, and by the sciatic ligaments, which is wide and dilatable, to permit the delivery of the child, but which being sometimes too wide, permits the child's head to press so suddenly, and with such violence upon the soft parts, that the perineum is torn. The THYROID HOLE is that remarkable vacancy in the bone which perhaps lightens the pelvis, or perhaps allows the soft parts to escape from the pressure, during the passage of the head of the child.

Outlet.

Thyroid hole.

Peculiarities of the female pelvis. *The marks of the female skeleton have been sought for in the skull, as in the continuation of the sagittal suture: but the truest marks are those which relate to that great function by which chiefly the sexes are distinguished: for while the male pelvis is large and strong, with a small cavity, narrow openings, and bones of greater strength, the female pelvis is very shallow and wide, with a large cavity, and slender bones, and with every peculiarity which*

* This condition of the brim is exhibited in a skeleton distorted by rickets, in my collection, now in the possession of the College of Surgeons of Edinburgh. The woman died in child-bed, and it was found that the arm of the child had escaped from the womb, at the place where it was cut by the sharp spine of bone.

may conduce to the easy passage of the child. And this occasions that peculiar form of the body which the painter is at great pains to mark, and which is indeed very easily perceived; for the characteristic of the manly form is firmness and strength; the shoulders broad, the haunches small, the thighs in a direct line with the body, which gives a firm and graceful step. The female form again is delicate, soft, and bending; the shoulders are narrow; the haunches broad; the thighs round and large; the knees, of course, approach each other, and the step is unsure: the woman even of the most beautiful form, walks with a delicacy and feebleness, which we come to acknowledge as a beauty in the weaker sex.

The bones of the pelvis compose a cavity which cannot be fairly understood in separate pieces, but which should be explained as a whole. Though perhaps its chief office is supporting the spine, still its relation to labour deserves to be observed; for this forms at least a curious inquiry, though it should not be allowed a higher place in the order of useful studies.

We know, from much experience, that where the pelvis is of the true size, we have an easy and natural labour: that where the pelvis is too large, there is pain and delay; but not that kind of difficulty which endangers life; that where, by distortion, the pelvis is reduced below the standard size, there comes such difficulty as endangers the mother, and destroys the child, and renders the art of midwifery still worthy of serious study, and an object of public care.

Of the change in the joining of the pelvis.

There was a time when it was universally believed, that the joinings of the pelvis dissolved in every labour; that the bones departed, and the openings were enlarged; that the child passed with greater ease; and "that this opening of the basin was no "less natural than the opening of the womb." By many accidents, this opinion has been often strengthened and revived; and if authority could determine our opinion, we should acknowledge, that the joinings of the pelvis were always dissolved as a wise

provision of nature for facilitating natural, and preventing lingering labour, compensating for the frequent deviations, both in the head and pelvis, from their true and natural size. This unlucky opinion has introduced, at one time, a practice the most reprehensibly simple, as fomentations to soften these joinings of the pelvis in circumstances which required very speedy help; while, at another time, it has been the apology for the most cruel unnatural operations of instruments, not merely intended for dilating and opening the soft parts, but for bursting up these joinings of the bones. And those also, of late years, who have invented and performed (too often, no doubt,) this operation of cutting the symphysis pubis to hasten the labour, say, that they do not perform an unnecessary cruel operation, but merely imitate a common process of nature.

How very far nature is from intending this, may be easily known from the very forms of these joinings, but much more from the other offices which these bones have to perform; for if the pelvis be, as I have defined it, an arch standing betwixt the trunk and the lower extremities on which the body rolls, its joinings could not part without pain and lameness, perhaps inability for life.

One chief reason drawn from anatomy is this: that in women dying after labour, the cartilages of the pelvis are manifestly softened; the bones loosen; and though they cannot be pulled asunder, they can be shuffled or moved upon each other in a slight degree: all which is easily accounted for. The cartilage that forms the symphysis pubis is not one cartilage only, as was once supposed, but a peculiar cartilage covers the end of each bone, and these are joined by a membraneous or ligamentous substance: this ligamentous substance is the part which corrupts the soonest: it is often spoiled, and in the place of it, a hollow only is found; that hollow of the corrupted ligament may be called a separation of the bones; but it is such a separation "as equals only the back of a common knife in

" breadth, and will not allow the bones to depart " from each other;" the joining is still strong, for it is surrounded by a capsular ligament, not like the loose ligament of a moveable joint, but adhering to every point of each bone; and this ligament does perform its office so completely, that while it remains entire, though the bones shuffle sideways upon each other, no force can pull them asunder: " Even when the *fore-part* of the pelvis " is cut out, and turned and twisted betwixt the " hands, still, though the bones can be bent back- " wards and forwards, they cannot be pulled from " each other the tenth part of an inch." These enquiries were made by one, who, though partial to the other side of this question, could not allow himself to disguise the truth, whose authority is the highest, and by whose facts I should most willingly abide.

Now, it is plain, that since a separation, amounting only to the 12th part of an inch, occasions death, this cannot be a provision of nature; and since the separation in such degree could not enlarge the openings of the basin, there again it cannot be a provision of nature. I know that tales are not wanting of women whose bones were separated during labour; but what is there so absurd, that we shall not find a precedent or parallel case in our annals of monstrous and incredible facts? Or, rather, where is there a fact of this description which is not balanced and opposed by opposite authorities and facts? I have dissected several women who have died in lingering labour, where I found no disunion of the bones. I have seen women opened, after the greatest violence with instruments, and yet found no separation of the bones. We have cases of women having the mollities ossium, a universal softness and bending of the bones, who have lived in this condition for many years, with the pelvis also affected; its openings gradually more and more abridged; the miserable woman suffering lingering labour, and undergoing the delivery by hooks, with all the

violence that must be used in such desperate cases, and still no separation of the bones happening. How, indeed, should there be such difficult labours as these, if the separation of the bones could allow the child to pass?

If it be said, "the joinings of the pelvis are "sometimes dissolved,"* I acknowledge that they are, just as the joint of the thigh is dissolved, that is, sometimes by violence, and sometimes by internal disease; but if it be affirmed that "the joinings of "the pelvis are dissolved to facilitate labour," I would observe, that wherever separation of the bones has happened, it has both increased the difficulties of the labour, and been in itself a very terrible disease; for proofs of which, I must refer to Hunter, Denman, and others, to whose peculiar province such cases belong. But surely these principles will be universally acknowledged; that the pelvis supporting the trunk is the centre of its largest motions: that if the bones of the pelvis were loosened such motions could no longer be performed: that when, by violence or by internal disease, or in the time of severe labour, these joinings have actually been dissolved or burst, the woman has become instantly lame, unable to sit, stand, or lie, or support herself in any degree; she is rendered incapable of turning, or even of being turned in bed; her attendants cannot even move her legs without intolerable anguish, as if torn asunder†: there sometimes follows a collection of matter within the joint (the matter extending quite down to the tuber ischii), high fever, delirium, and death‡; or, in case of recovery (which is indeed more frequent), the recovery is slow and partial only; a degree of lameness remains,

* I have known the synchondrosis pubis burst by straining. The man stood over the weight which he strained to lift, and felt something give way. The case terminated in suppuration around the joint and caries of the ossa pubis. See my Collection.

† Denman.

‡ Dr. Hunter, Med. Observ. and Enquir. Vol. ii. p. 321.

with pain, weakness, and languid health: they can stand on one leg more easily than on both; they can walk more easily than they can stand; but it is many months before they can walk without crutches; and long after they come to walk upon even ground, climbing a stair continues to be very difficult and painful. In order to obtain even this slow re-union of the bones, the pelvis must be bound up with a circular bandage very tight; and they must submit to be confined long: by neglect of which precautions, sometimes by the rubbing of the bones, a preternatural joint is formed, and they continue lame for years, or for life *; or sometimes the bones are united by ossification; the callus or new bone projects towards the centre of the pelvis, and makes it impossible for the woman to be again delivered of a living child.†

Now this history of the disease leads to reasons independent of anatomy, which prove, that this separation of the bones (an accident the existence of which cannot be questioned) is not a provision of nature, but is a most serious disease. For if these be the dreadful consequences of separation of the bones, how can we believe that it happens, when we see women walking during all their labour, and, in place of being pained, are rather relieved by a variety of postures, and by walking about their room? who often walk to bed after being delivered on chairs or couches? who rise on the third day, and often resume the care and fatigues of a family in a few days more? or can we believe, that there is a tendency to separation of the bones in those who, following the camp, are delivered on one day and walk on the following? or in those women who, to conceal their shame, have not indulged in bed a single hour? or can we believe, that there is even the slightest tendency to the separation of the bones in those women whose pelvis resists the force of a lingering and severe labour, who suffer still further all the violence of instru-

* Denman says twenty-five or thirty years.

† Spence's cases.

ments, who yet recover as from a natural delivery, and who also rise from bed on the third or fourth day? I have only to add to this catalogue of evils attending the separation of the symphysis or sychondrosis in the female pubis, that I have known the bones separated by violence in man, and the accident was attended with tedious suppuration and hectic.

BONES OF THE THIGH, LEG, AND FOOT.

The THIGH-BONE is the greatest bone of the body, and needs to be so, supporting alone, and in the most unfavourable direction, the whole weight of the trunk; for though the body of this bone is in a line with the trunk, in the axis of the body, its neck stands off almost at right angles with the body of the bone; and in this unfavourable direction must it carry the whole weight of the trunk, for the body is seldom so placed as to rest its weight equally upon either thigh-bone, as commonly it is so inclined from side to side alternately, that the neck of one thigh-bone bears alone the whole weight of the body and limbs, or is loaded with still greater burdens than the mere weight of the body itself.

Femur; general form cylindrical; The thigh-bone is one of the most regular of the cylindrical bones. Its BODY is very thick and strong, of a rounded form, swelling out at either end into two heads. In its middle it bends a little outwards, with its circle or convex side turned towards the curved. fore part of the thigh. This bending of the thigh-bone has been a subject of speculation abundantly ridiculous, viz. whether this be an accidental or a natural arch. There are authors who have ascribed it to the nurse carrying the child by the thighs, and its soft bones bending under the weight. There is another author, very justly celebrated, who imputes it to the weight of the body, and the stronger action of the flexor muscles, affirming, that it is straight in

the child, and grows convex by age. This could not be, else we should find this curve less in some, and greatest in those who had walked most, or whose muscles had the greatest strength: and if the muscles did produce this curve, a little accident giving the balance to the flexor muscles would put the thigh-bone in their power, to bend it in any degree, and to cause distortion. But the end of all such speculations is this, that we find it bended in the fœtus, not yet delivered from the mother's womb, or in a chicken while still enclosed in the shell; it is a uniform and regular bending, designed and marked in the very first formation of the bone, and intended, perhaps, for the advantage of the strong muscles in the back of the thigh, to give them greater power, or more room.

The HEAD of the thigh bone is likewise the most perfect of any in the human body, for its circumference is a very regular circle, of which the head contains nearly two thirds: it is small, neat, and completely received into its socket, which is not only deep in itself, and very secure, but is further deepened by the cartilage which borders it, so that this is naturally, and without the help of ligaments, the strongest joint in all the body; but among other securities which are superadded, is the round ligament, the mark of which is easily seen, being a broad dimple in the centre of its cavity. In the surface of the head or ball we observe a small pit for the attachment of the round ligament of the hip-joint.

Head being more than half a circle.

Pit.

The NECK of this bone is the truest in the skeleton; and indeed it is from this neck of the thigh-bone, that we transfer the name to other bones, which have hardly any other mark of neck than that which is made by their purse-like ligament being fixed behind the head of the bone, and leaving a roughness there. But the neck of the thigh-bone is more than an inch in length, thick, and strong, yet hardly proportioned to the great weights which it has to bear; long, that it may allow the head to be set deeper in its socket; and standing wide up from the

Neck.

shoulders of the bone, to keep its motions wide and free, and unembarrassed by the pelvis; for without this great length of the neck, its motions had been checked even by the edges of its own socket.

Trochanter. The TROCHANTERS are the longest processes in the human body for the attachment of muscles, and they are named trochanter (or processes for turning the thigh), from their office, which is the receiving those great muscles which not only bend and extend the thigh, but turn it upon its axis; or these processes are oblique, so as to bend and turn the thigh at once.

Major. The TROCHANTER MAJOR, the outermost and longer of the two, is that great bump which represents the direct end of the thigh-bone, while the neck stands off from it at one side; therefore the great trochanter stands above the neck, and is easily distinguished outwardly, being that great bump which we feel so plainly in laying the hand upon the haunch. On the upper and fore part of this great process, are two surfaces for the insertion of the gluteus medius and minimus.

The extremity of the great trochanter hangs over a pit into which principally the small rotator muscles of the thigh are inserted, viz. the pyriformis, the gemini, the obturator internus and externus. On the lower part there is a very strong marked ridge, which is for the insertion of the gluteus maximus.

Tr. minor. The TROCHANTER MINOR, or lesser trochanter, is a smaller and more pointed rising on the inner side of the bone, lower than the trochanter major, and placed under the root of the neck, as the greater one is placed above it. It is directed backwards, so that the muscles inserted into it turn the toe outwards at the same time that they raise the femur. It is deeper in the thigh, and never to be felt, not even in luxations. Its muscles, also, viz. the flexors of the thigh, by the obliquity of their insertion into it, turn the thigh, and bend it towards the body, such as the psoas and iliacus internus, which, passing out from the pelvis, sink deep into the groin, and are implanted

into this point. On the neck of the thigh-bone there is a very conspicuous roughness, which marks the place of the capsule or ligamentary bag of the joint; for it encloses the whole length of the neck of the thigh-bone.

Betwixt the greater and lesser trochanters, there runs a rough line, the *inter-trochantral line*, to which the capsular ligament is attached, and into which the quadratus femoris is inserted. Inter-trochantral line.

The LINEA ASPERA is a rising or prominent line, very rugged and unequal, which runs all down the back part of the thigh: it begins at the roots of the two trochanters, and the rough lines from each trochanter meet about four inches down the bone; thence the linea aspera runs down the back of the bone a single line, and forks again into two lines, one going towards each condyle, and ending in the tubercles at the lower end of the bone, so that the linea aspera is single in the middle, and forked at either end. Linea aspera. Double above, and below.

The CONDYLES are the two tubers, into which the thigh-bone swells out at its lower part. There is first a gentle and gradual swelling of the bone, then an enlargement into two broad and flat surfaces, which are to unite with the next bone in forming the great joint of the knee. The two tuberosities, which, by their flat faces, form the joint, swell out above the joint, and are called the CONDYLES. The INNER CONDYLE is larger, to compensate for the oblique position of the thigh-bone; for the bones are separated at their heads by the whole width of the pelvis, but are drawn towards a point below, so as to touch each other at the knees. On the fore part of the bone, betwixt the condyles, there is a broad smooth surface upon which the rotula, patella, or pulley-like bone glides. The outer side of this trochlea is the largest and most prominent. On the back part of the thigh-bone, in the middle betwixt the condyles, there is a deep notch, which gives passage to the great artery, vein, and nerve, of the leg. Condyles. The inner largest. Trochlea. Notch.

Nutritious artery.

The great nutritious artery enters below the middle of this bone, and smaller arteries enter through its porous extremities; as may be known by many small holes near the head of the bone.

Review of the principal points of demonstration.

The HEAD of the thigh-bone is round, and set down deeply in its socket, to give greater security to a joint so important, and so much exposed as the hip is. The NECK stands off from the rest of the bone, so that by its length it allows a free play to the joint, but is itself much exposed by its transverse position, as if nature had not formed in the human body any joint at once free, moving, and strong. The neck is not formed in the boy, because the socket is not yet deep, nor hinders the motions of the thigh, and the head is formed apart from the bone, and is not firmly united with it till adult years, so that falls luxate or separate the head in young people, but they break the neck of the bone in those that are advanced in years. The TROCHANTERS, or shoulders, are large, to receive the great muscles which are implanted in them, and oblique, that they may at once bend and turn the thigh. The SHAFT or BODY is very strong, that it may bear our whole weight, and the action of such powerful muscles; and it is marked with the rough line behind, from which a mass of flesh takes its rise, which wraps completely round the lower part of the thigh-bone, and forms what are called the vasti muscles, the greatest muscles for extending the leg. The CONDYLES swell out to give a broad surface, and a firm joining for the knee. But of all its parts, the great trochanter should be most particularly observed, as it is the chief mark in luxations or fractures of this bone: for when the greater trochanter is pushed downwards, we find the thigh luxated inward; when the trochanter is higher than its true place, and so fixed that it cannot roll, we are assured that it is luxated: but when the trochanter is upwards, with the thigh rolling freely, we are assured its neck is broken, the trochanter being displaced, and the

broken head remaining in its socket; but when the trochanter remains in its place, we should conclude that the joint is but little injured, or that it is only a bruise of those glands or mucous follicles, which are lodged within the socket, for lubricating the joint.

The TIBIA is named from its resemblance to a pipe; the upper part of the tibia, representing the expanded or trumpet-like end, the lower part representing the flute end of the pipe. The tibia, on its upper end, is flat and broad, making a most singular articulation with the thigh-bone; for it is not a ball and socket like the shoulder or hip, nor a hinge joint guarded on either side with projecting points, like the ancle. There is no security for the knee-joint, by the form of its bones, for they have plain flat heads; they are broad indeed, but they are merely laid upon each other. It is only by its ligaments that this joint is strong; and by the number of its ligaments it is a complex and delicate joint, peculiarly liable to disease. Tibia Form.

The UPPER HEAD of the tibia is thick and spongy, and we find there two broad and superficial hollows, as if impressed, while soft, with the marks of the condyles of the thigh-bone; and these slight hollows are all the cavity that it has for receiving the thigh-bone. A pretty high ridge rises betwixt these two hollows, so as to be received into the interstice betwixt the condyles, on the back part, which is the highest point of the ridge. There is a pit on the fore and on the back part for the attachment of the crucial ligaments. The spongy head has also a rough margin, to which the capsular ligament is tied. On the fore part of this bone, just below the knee, there is a bump for receiving the great ligament of the patella, or, in other words, the great tendon of all the extensor muscles of the leg: and lastly, there is upon the outer side of this spongy head, just under the margin of the joint, a smooth articulating surface, (like a dimple impressed with the finger,) for re- Upper head. Two articulating surfaces. Ridge. Pits. Margin. Tubercle. Articulating surface for the fibula.

ceiving the head of the fibula. It is under the margin of the joint, for the fibula does not enter at all into the knee-joint; it is only laid upon the side of the tibia, fixed to it by ligaments, but not received into any thing like a cavity.

Body triangular.

The BODY or shaft of the bone is of a prismatic or triangular form, and its three edges or acute angles are very high lines running along its whole length. The whole bone is a little twisted to give a proper position to the foot. One line, the anterior angle, a little waved, and turned directly forwards, is what is called the shin. At the top of this ridge is that bump into which the ligament of the rotula or patella is implanted; and the whole length of this acute line is so easily traced through the skin, that we can never be mistaken about fractures of this bone. Another line, less acute than this, is turned directly backwards; and the third acute line, which completes the triangular form, is turned towards the fibula, to receive a broad ligament, or interosseous membrane, which ties the two bones together.

Shin.

Posterior angle.

Lateral angle.

The middle of the posterior surface of the bone is hollowed for the lodgment of the muscles, which extend the foot and bend the toes; and the anterior and outer surface is hollowed by the lodgment of that muscle, which is called tibialis anticus, and the long extensors of the toes.

On the back part of the bone, near its head, there is a flat surface made by the insertion of the popliteus muscle, which is bounded on the lower part by a ridge giving origin to one of the flexors.

Lower head.

The lower head of the tibia composes the chief part of the ancle-joint. The lower head is smaller than the upper, in the same proportion that the ancle is smaller than the knee. The pointed part of this head of the tibia represents the mouth-piece, or flat part of the pipe, and constitutes the bump of the INNER ANCLE. The lower end of the fibula lies so upon the lower end of the tibia, as to form the outer ancle; and there is on the one side of the tibia a deep hollow, like an impression made

Malleolus internus.

Impression of the fibula.

with the point of the thumb, which receives the lower end of the fibula. The acute point of the tibia, named the process of the inner ancle, passes beyond the bone of the foot, and by lying upon the side of the joint, guards the ancle, so that it cannot be luxated outward, without this pointed process of the malleolus internus, or inner ancle, being broken. The lower extremity of the tibia has that sort of excavation to correspond with the astragalus, to which anatomists give the name of scaphoid cavity. Scaphoid cavity.

On the back of the lower head of the bone there is a groove which transmits the tendon of the tibialis posticus muscle, and at its apex a pit giving origin to the deltoid ligament. Groove for the tibialis posticus.

On the back part of the tibia, and a little below its head, we have to observe the hole for the transmission of the nutritious artery to the centre of the bone. In amputation of the leg, this artery is sometimes cut across just where it has entered the bone, and the bleeding proves troublesome.

The tibia is a bone of great size, and needs to be so, for it supports the whole weight of the body. It is not at all assisted by the fibula in bearing the weight, the fibula, or slender bone, being merely laid upon the side of the tibia, for uses which shall be explained presently. The tibia is thick, with much cancelli or spongy substance within; has pretty firm plates without; is much strengthened by its ridges, and by its triangular form: its ridges are regular with regard to each other, but the whole bone is twisted as if it had been turned betwixt the hands when soft: this distortion makes the process of the inner ancle lie not regularly upon the side of that joint, but a little obliquely forward, which determined the obliquity of the foot, and this must be of much consequence, since there are many provisions for securing this turning of the foot, viz. the oblique position of the trochanters, the oblique insertion of all the muscles, and this obliquity of the ancles; the inner ancle advancing a little before the joint, and the outer ancle receding in the same degree behind it.

Fibula. The FIBULA, which is named so from its resemblance to the Roman clasp, is a long slender bone, which is useful partly in strengthening the leg, but chiefly in forming the ancle-joint and in affording attachment to muscles. The tibia only is connected with the knee, while the fibula, which has no place in the knee-joint, goes down below the lower end of the tibia, forming the long process of the outer ancle.

The fibula is a long and slender bone, the longest and slenderest in the body. It lies by the side of the tibia like a splint, so that when at any time the tibia is broken without the fibula, or when the tibia, having spoiled, becomes carious, and a piece of it is lost, the fibula maintains the form of the limb till the last piece be replaced, or till the fracture be firmly re-united. It is, like the tibia, triangular in the middle part, but square towards the lower end, and has two heads, which are knots, very large, and disproportioned to so slender a bone. The sharpest line of the fibula is turned to the sharp line of the tibia, and the interosseous membrane passes betwixt

Spines. them. The other lines or spines are in the interstices of the attachment of muscle, of which no fewer than six take their origin here, making the bone irregular with spines and grooves. There arise from the fibula, 1. The soleus from the back part of the head; 2. The tibialis posticus from the back and lower part of the bone; 3. The flexor longus pollicis all down the back part of the bone; 4. The peroneus longus from nearly the whole length of the bone; 5. The peroneus brevis from the middle and lower part; 6. The peroneus tertius from the fore part of the bone. The bone lies in a line with the tibia, on the outer side of

Upper head. it, and a little behind it. The upper head of the fibula is rough on the outer surface, for the insertion of the lateral ligament, and of the *biceps cruris;* smooth, and with cartilage within; and is laid upon a plain smooth surface, on the side of the tibia, a

Firmly united to the tibia. little below the knee: and though the fibula is not received deep into the tibia, this want is compensated for by the strong ligaments by which this little

joint is tied; by the knee being completely wrapped round with the expanded tendons of those great muscles which make up the thigh; by the knee being still farther embraced closely by the fascia, or tendinous expansion of the thigh; but above all, by the tendons of the outer hamstrings being fixed into this knot of the fibula, and expanding from that over the fore part of the tibia.

The lower head of the fibula is broad and flat, and is let pretty deep into a hollow on the side of the tibia; together they form the socket of the ancle-joint for receiving the bones of the foot. The extreme point of the thin extremity gives attachment to the perpendicular ligament of the joint, and is called the malleolus externus. On the back part of this lower head there is a furrow which lodges the tendons of the peronei muscles. The ancle-joint is one of the purest hinge-joints, and is very secure; for there is the tibia, at the process of the inner ancle, guarding the joint within, there is the fibula passing the joint still further, and making the outer ancle still a stronger guard without. These two points, projecting so as to enclose the bones of the foot, making a pure hinge, prevent all lateral motion; make the joint firm and strong, and will not allow of luxations, till one or both ancles be broken. We know that there is little motion betwixt the tibia and fibula; none that is sensible outwardly, and no more in truth than just to give a sort of elasticity, yielding to slighter strains. But we are well assured that this motion, though slight and imperceptible, is very constant; for these joinings of the fibula with the tibia are always found smooth and lubricated; and there are no two bones in the body so closely connected as the tibia and fibula are, and which are so seldom anchylosed, *i. e.* joined into one by disease.

Lower head.

Malleolus externus.

Ancle-joint.

The fibula may be thus defined: it is a long slender bone, which answers to the double bone of the fore-arm, completes the form, and adds somewhat to the strength of the leg; it gives a broader origin for its strong muscles, lies by the side of the

General description of the fibula.

tibia like a splint; and being a little arched towards the tibia, supports it against those accidents which would break it across, and maintains the form of the leg when the tibia is carious or broken; the fibula, though it has little connection with the knee, passes beyond the ancle-joint, and is its chief guard and strength in that direction in which the joint should be most apt to yield; and in this office of guarding the ancle, it is so true, that the ancle cannot yield till this guard of the fibula be broken. This fracture of the lower part of the fibula, attended with more or less injury of the inner ligament of the ancle-joint, is by far the most frequent accident received into a London hospital.

Patella. PATELLA, ROTULA, OR KNEE-PAN, is a small thick bone, of an oval, or rather triangular form. The Basis. basis of this rounded triangle is turned upwards to receive the four great muscles which extend the leg; Apex. the pointed part of this triangle is turned downwards, and is tied by a very strong ligament to the bump or tubercle of the tibia, just under the knee. The convex surface is rough, the concave smooth, and Ridge. divided by a ridge into two unequal parts: round the margin of the bone there is a slight depression for the attachment of the capsular ligament. This ligament is called the ligament of the patella, or of the tibia, connecting the patella so closely, that some anatomists of the first name choose to speak of the patella as a mere process of the tibia, (as the olecranon is a process of the ulna,) only flexible and loose; an arrangement which I think so far right and useful, as the fractures of the olecranon and of the patella are so much alike, especially in the method of cure, that they may be spoken of as one case; for these two are exceptions to the common rules and methods of setting broken bones.

The patella is manifestly useful, chiefly as a lever; for it is a pully, which is a species of lever, gliding upon the fore part of the thigh-bone, upon the smooth surface which is betwixt the condyles. The projection of this bone upon the knee removes the

acting force from the centre of motion, so as to increase the power; and it is beautifully contrived, that while the knee is bent, and the muscles at rest, as in sitting, the patella sinks down, concealed into a hollow of the knee. When the muscles begin to act, the patella begins to rise from this hollow; in proportion as they contract, they lose of their strength, but the patella, gradually rising, increases the power; and when the contraction is nearly perfect, the patella has risen to the summit of the knee, so that the rising of the patella raises the mechanical power of the joint in exact proportion as the contraction expends the living contractile power of the muscles. What is curious beyond almost any other fact concerning the fractures of bones, the patella is seldom broken by a fall or blow; in nine of ten cases, it is rather torn, if we may use the expression, by the force of its own muscles, while it stands upon the top of the knee, so as to rest upon one single point; for while the knee is half-bended, and the patella in this dangerous situation, the leg fixed, and the muscles contracting strongly to support the weight of the body, or to raise it as in mounting the steps of a stair, the force of the muscles is equivalent at least to the weight of the man's body; and often, by a sudden violent exertion, their power is so much increased, that they snap the patella across, as we would break a stick across the knee.

The TARSUS, OR INSTEP, is composed of seven large bones, which form a firm and elastic arch for supporting the body; which arch has its strength from the strong ligaments with which these bones are joined, and its elasticity from the small movements of these bones with each other; for each bone and each joint has its cartilage, its capsule or bag, its lubricating fluid, and all the apparatus of a regular joint; each moves, since the cartilages are always lubricated, and the bones are never joined by anchylosis with each other; but the effect is rather a diffused elasticity than a marked and perceptible motion in any one joint. Of the tarsus.

The seven bones of which the tarsus is composed are, 1. The ASTRAGALUS, which, united with the tibia and fibula, forms the ancle-joint. 2. The OS CALCIS, or heel-bone, which forms the end or back point of that arch upon which the body stands. 3. The OS NAVICULARE, or boat-like bone, which joins three smaller bones of the fore part of the tarsus to the astragalus. 4. The OS CUBOIDES, which joins the fore part of the os calcis to the external cuneiform bone. The 5th, 6th, and 7th, are the smaller bones making the fore part of the tarsus; they lie immediately under the place of the shoe-buckle, and are named the three CUNEIFORM BONES, from their wedge-like shape; and it is upon these and the anterior surface of the cuboides that the metatarsal bones, forming the next division of the foot, are implanted.

These bones of the tarsus form, along with the metatarsal bones, a double arch: first, from the lowest point of the heel to the ball of the great toe, is one arch, the arch of the sole of the foot which supports the body; then there is a transverse arch formed by the cuboides and the cuneiform bones; and again, there is another arch within this, formed among the tarsal bones themselves, one within another, and laid horizontally, *i. e.* betwixt the astragalus, os calcis, cuboides, cuneiform bones, and naviculare. It is these arches which give so perfect an elasticity to the foot, and must prevent the bad effects of leaping, falls, and other shocks, which would have broken a part less curiously adapted to its office.

Astragalus. (1.) The ASTRAGALUS is the greatest and most remarkable bone of the tarsus, and which the surgeon is most concerned in knowing. The semicircular head of this bone forms a curious and perfect pully. The circle of this pully is large; its cartilage is smooth and lubricated; it is received deep betwixt the tibia and fibula, and rolls under the smooth articular surface of the latter, which, being suited to this pully of the astragalus, with something of a boat-like shape, is often named the scaphoid cavity of the

General description.

tibia. 1. We remark in the astragalus its articulating surface, which is arched, high, smooth, covered with cartilage, lubricated, and in all respects a complete joint. Its form is that of a pully, which, of course, admits of but one direct motion, viz. forwards and backwards. 2. We observe its sides, which are plain, smooth, and flat, covered with the same cartilage, forming a part of the joint, and closely locked in by the inner and outer ancles, so as to prevent luxations, or awkward motions to either side. 3. We observe two large irregular articulating surfaces, backwards and downwards, by which it is joined to the os calcis. 4. There is on the fore part, or rather the fore end, of the astragalus, a large round head, as regular as the head of the shoulder-bone, by which it is articulated with the scaphoid bone.

Points of demonstration. Trochlea. Internal articulating surface. External surface. Inferior posterior. Inferior anterior. Ball. Smooth surface.

1. Superior surface corresponding with the scaphoid cavity of the tibia. 2. Internal articulating surface for the malleolus internus. 3. External articulating surface for the extremity of the fibula. 4. Inferior and posterior articulating surface joining with the body of the os calcis. 5. Inferior and anterior surface articulating also with a corresponding surface of the os calcis. 6. The ball or anterior articulating surface which enters into the socket of the naviculare. 7. A smooth part, which is like a continuation of this last, but which rests upon a cord of ligament, which is stretched betwixt the os calcis and naviculare. 8. Deep fossa, dividing these two inferior articulating surfaces, for the lodgment of a ligament which unites this bone to the os calcis. 9. Furrow for attachment of the capsular ligament. On the inside of the bone we see a hollow and a rough protuberance for the attachment of the deltoid ligament, which comes down from the tibia; a point of the anatomy of the first consequence to the surgeon.

Fossa. Attachment of the deltoid ligament.

Os calcis. Great process.

(2.) The OS CALCIS is the large irregular bone of the heel; it is the tip or end of the arch formed by the tarsal and metatarsal bones. There is an irregular surface on the highest part of the projection

backwards, to which the tendo Achillis is inserted.
First. The lower and back part of the bone is rough, but peculiar in its texture, for the attachment of the cartilaginous and cellular substance on which it rests.
Second. We next notice an irregular articular surface, or rather two surfaces covered with cartilage, by which this bone is joined with the astragalus.
Third articulating surface. Another articulating surface by which it is joined with the os cuboides.
Arch. A sort of arch or excavation, on the inside, under which the vessels and nerves, and the tendons also, pass on safely into the sole of the foot.
Groove. On the outer surface of this bone we may observe a groove, which transmits the tendon of the peroneus longus.

On the upper surface of the bone, and betwixt the surfaces which articulate with the astragalus, there
Fossa. is an irregular rough fossa, which is opposite to a corresponding depression in the astragalus, and which gives attachment to powerful ligaments which unite the bones; and, on the lower and inner part, is the sinuosity.

Tubercle. We further notice the tubercle which stands internally, and gives attachment to the ligamentum inter os calcis et naviculare, which forms an elastic support to the lower part of the ball of the astragalus.

Naviculare. (3.) The next bone is named OS NAVICULARE, or OS SCAPHOIDES, from a fanciful resemblance to a boat. But this is a name to which anatomists have been very partial, and which they have used with very little discretion or reserve: the student will hardly
Concave surface. find any such resemblance. That concave side which looks backwards is pretty deep, and receives the
Convex surface. head of the astragalus: that flat side which looks forward has not so deep a socket, but receives the three cuneiform bones upon a surface rather plain
Tubercle. and irregular. From the inner and lower part of this bone a tubercle stands out for the attachment of a powerful gristly ligament, already described, running betwixt this and the os calcis.

Cuneiform bones. (4, 5, 6.) The CUNEIFORM BONES are so named, because they resemble wedges, being laid close to each

other like the stones of an arch. The most simple and proper arrangement is 1, 2, and 3; counting from the side of the great toe towards the middle of the foot; but they are commonly named thus: the first cuneiform bone, on which the great toe stands, has its cutting edge turned upwards; it is much larger than the others, and so is called OS CUNEIFORME MAGNUM. The second cuneiform bone, or that which stands in the middle of the three cuneiform bones, is much smaller, and is therefore named OS CUNEIFORME MINIMUM. The third in order, of the cuneiform bones, is named OS CUNEIFORME MEDIUM.* These cuneiform bones receive the great toe and the two next to it. The fourth and fifth toes are implanted upon the os cuboides.

Os cuneiforme magnum.

Minimum.

Medium.

(7.) OS CUBOIDES. — The os cuboides is named from its cubical figure, and is next to the astragalus in size, and greater than the os naviculare. The three cuneiform bones are laid regularly by the side of each other; and this os cuboides is again laid on the outer side of the third cuneiform bone, and joins it to the os calcis. Its anterior point is divided into two surfaces, for two metatarsal bones: in the lower surface of the bone is a groove for transmitting the tendon of the long peroneus muscle. The place and effect of the cuboid bone is very curious; for as it is jammed in betwixt the third cuneiform bone and the os calcis, it forms a complete arch within an arch, which gives at once a degree of elasticity and of strength which no human contrivance could have equalled.

Cuboides.

Surface for the third cuneiform bone.

Articulated with os calcis.

Groove.

Place and use.

METATARSUS. — The metatarsus, so named from its being placed upon the tarsus, consists of five bones; they extend betwixt the tarsus and the proper bones of the toes.

* The confusion in these names arises from sometimes counting them by their place, and sometimes reckoning according to their size. It is only in relation to its size that we call one of these bones os cuneiforme medium; for the os cuneiforme medium is not in the middle of the three; it is the middle bone with respect to size: it is the smallest of the cuneiform bones that stands in the middle betwixt the other two.

Distinctions. The metatarsal bone of the great toe is the shortest, and is otherwise distinguished by its strength and the great size of its extremities. The metatarsal of the second toe is the longest, its nearer head being wedged betwixt the cuneiforme magnum and minimum, while it has a surface of contact with the medium and the head of the extremity of the metatarsal bone of the third toe. The metatarsal bone of the little toe is also peculiar in the size of its nearer head, and the manner in which that head projects upon the outside of the foot to receive the tendons of the peroneus secundus and tertius. General form. The metatarsal bones generally have these peculiarities. They are rather flattened, especially on their lower sides, where the tendons of the toes lie; they have a ridge on their upper or arched surface; they are very large at their ends next the tarsus, where they have broad square heads, that they may be implanted with great security; they grow smaller forwards, where again they terminate, in neat small round heads, which receive the first bones of the toes, and permit of a very free and easy motion in them, and a greater degree of rotation than our dress allows us to avail ourselves of, the toes being cramped together, in a degree that fixes them all in their places, huddles one above another, and is quite the reverse of that free and strong-like spreading of the toes, which the painter always represents.

Ball. The further extremities of these bones terminate in round balls, which correspond with the sockets Groove. in the first bones of the toes, and a distinct groove runs round the upper part of the extremity of the Condyles. bone for the attachment of the capsule. Processes stand out laterally from the anterior extremities, which give attachment to the lateral ligaments of the joint. These bones, by the connection of their nearer extremities, form an arch corresponding with the lateral arch of the tarsus: owing to this the metatarsal of the great toe is placed on a lower level, so that its great extremity projects into the sole of the foot, and into it are inserted part of the

tendon of the tibialis posticus, and the peroneus longus, whilst the tibialis anticus is inserted into its upper surface.

The marks of the metatarsal bones are chiefly useful as directing us where to cut in amputating these bones; and the surgeon will save the patient much pain, and himself the shame of a slow and confused operation, by marking the places of the joints, and the form of the extremities of the bones.

THE TOES.—The last division of the foot consists of three distinct bones; and as these bones are disposed in rows, they are named the first, second, and third phalanges or ranks of the toes.

The great toe has but two phalanges; the other toes have three ranks of bones: these bones are a little flattened on their lower side, or rather, they have a flattened groove which lodges the tendons of the last joint of the toes. The articulating surfaces of the nearer extremities of the first bones are deep sockets for the extremities of the metatarsal bones, and the motions are free. But the articulations of the second and third joints are proper hinge joints, the further extremities of the first and second bones being a flattened trochlea. It is particularly to be noticed, that the heads of these bones are large, and that they send out a lateral projection for the attachment of the lateral ligament. The consideration of the size and form of the extremities of these bones, and the nature and attachment of their ligaments, is of the first importance, as explaining the peculiarity in the dislocation of these bones, and the manner of reduction.

Their extremities large.

The SESAMOID BONES are more regularly found about the toes than any where else. They are small bones, like flattened peas, found in tendons, at the points where they suffer much friction; or rather they are like the seeds of the sesamum, whence their name. They are found at the roots of the great toe, and of the thumb. We find two small sesamoid bones, one on each side of the ball of the great

toe; and grooves may be observed on the lower part of the articulating surface of that bone, for their lodgment and play: they are within the substance of the tendons; perhaps, like the patella, they remove the acting force from the centre of motion, and so, by acting like pullies, they increase the power; perhaps, also, by lying at the sides of the joint in the tendons of the shorter muscles of the toes, they make a safe gutter for the long tendons to pass in. They are not restricted to the balls of the great toe and thumb, but sometimes are also found under the other toes and fingers, and sometimes behind the condyles of the knee; or in the peronei tendons, which run under the sole of the foot.

BONES OF THE SHOULDER, ARM, AND HAND.

OF THE SCAPULA, OR SHOULDER-BLADE.

This is the great peculiarity of the superior extremity, that it is connected not directly with the trunk, like the thigh-bone with the haunch, but is hung by a moveable intermediate bone, and not only is not immediately joined to the trunk by ligaments, nor any other form of connection, but is parted from it by several layers of muscular flesh, so that it lies flat, and glides upon the trunk.

Scapula. General description. The SCAPULA is a thin bone, which has originally, like the skull, two tables, and an intermediate diploe; but it grows gradually thinner, its tables are more and more condensed, till in old age it has become in some parts transparent, and is supported only by its processes, and by its thicker edges; for its SPINE is a ridge of firm and strong bone, which rises very high, and gives a broad origin and support for its muscles. The ACROMION, in which the spine terminates, is a broad and flat process, a sure guard

for the joint of the shoulder. The CORACOID process is a strong but shorter process, which stands out from the neck of the bone; and the COSTA, or borders of the bone, are also rounded, firm, and strong, so that the processes and borders support the flat part of the bone, which is as thin as a sheet of paper.

There is no part nor process of the scapula which does not require to be very carefully marked; for no accidents are more frequent than luxations of the shoulder; and the various luxations are explained best by studying the skeleton, and being able to recognize on the living body all the processes and projecting points.

Surfaces.

The FLAT SIDE of the scapula is smooth, somewhat concave, and suited to the convexity of the ribs: it is sometimes called VENTER. The scapula is connected with no bone of the trunk, tied by no ligaments, is merely laid upon the chest, with a large mass of muscular flesh under it, upon which it glides, being limited only by the clavicle: there are below it two layers of muscles, by one of which the shoulder-bone is moved upon the scapula, while by the other, the scapula itself is moved upon the ribs. The subscapularis muscle, lying in the hollow of the scapula, marks it with many smooth hollows, and wave-like risings, which are merely the marks of the several divisions of this muscle, but which were mistaken even by the great Vesalius for the impressions of the ribs.

Venter or lower surface.

Exterior surface or dorsum.

The upper or exterior flat surface is slightly convex; it is traversed by the SPINE, which is a very acute and high ridge of bone; it is called the DORSUM SCAPULÆ. Now the spine thus traversing the bone from behind forwards, divides its upper surface into two unequal parts, of which the part above the spine is smaller, and that below the spine is larger. Each of these spaces has its name, one supra spinatus, and the other infra spinatus; and each of them lodges a muscle, named, the one the musculus supra spinatus scapulæ, as being above the spine; the

Divided into fossa supra, and infra spinata.

other musculus infra spinatus scapulæ, as being below the spine. A third muscle is named subscapularis, as lying under the shoulder-blade, upon that concave surface which is towards the ribs; so that the whole scapula is covered with broad flat muscles, whose offices are to move the humerus in various directions, and which impress the scapula with gentle risings and hollows on its upper as well as on its lower surface.

Scapula triangular. Superior costa. Notch. Inferior costa.

The TRIANGULAR form of the scapula must be next observed. The upper line of the triangle is the shortest; it is named the SUPERIOR COSTA or border; here the omo-hyoideus has its origin. On this superior edge is seen the notch, through which a nerve and sometimes an artery passes. The lower edge, which is named the COSTA INFERIOR, or the lower border of the scapula, receives no muscles; because it must be quite free to move and glide as the scapula turns upon its axis, which is indeed its ordinary movement. But it gives rise to two smaller muscles, which, from being a little rounded, are named the musculi teretes; they leave their impressions on this lower costa.

Basis.

The long side of the scapula, which bounds its triangular form backwards, is named the BASIS of the SCAPULA, as it represents the base of the triangle. This line is also like the two borders, a little thicker or swelled out; and this edge receives powerful muscles, which lie flat upon the back, and coming to the scapula, in a variety of directions, can turn it upon its axis: sometimes raising, sometimes depressing the scapula; sometimes drawing it backwards; and sometimes fixing it in its place; according to the various sets of fibres which are put into action. These are the larger and lesser rhomboid muscles, and the great serrated muscle of the fore part of the chest, which runs under the scapula to be inserted into the inner edge of the base of the bone.

Angles. Superior. Inferior.

The angles of the scapula are two, the superior more obtuse, and the inferior more acute. From the inferior angle the teres major takes its origin, and

the outer surface of the bone is made smooth by the passage of the latissimus dorsi muscle. To the superior angle the levator scapulæ is inserted.

Glenoid cavity. The GLENOID OR ARTICULATING CAVITY of the scapula is on the point or apex of this triangle. The scapula is more strictly triangular in a child, for it terminates almost in a point or apex; and this articulating surface is a separate ossification, and is joined to it in the adult. The scapula towards this point terminates in a flat surface, not more than an inch in diameter, very little hollowed, and scarcely receiving the head of the shoulder-bone, which is rather laid upon it than sunk into it: it is indeed deepened a little by a circular gristle, which tips the edges or lips of this articulating surface, but so little, that it is still very shallow and plain, and luxations of the shoulder are infinitely more frequent than of any other bone.

Neck. This head, or glenoid cavity of the scapula, is planted upon a narrower part, which tends towards a point, but is finished by this flat head; this narrower part is what is named the NECK of the SCAPULA, which no doubt sometimes gives way, and breaks.* A rough line bordering the glenoid cavity receives the capsular ligament, or rather the capsule arises from the bordering gristle, which I have said tips this circle.

Spine. The SPINE of the SCAPULA is that high ridge of bone which runs the whole length of its upper surface, and divides it into two spaces for the origin of the supra and infra spinatus muscles. It is high and very sharp, standing up at one place to the height of two inches. It is flattened upon the top, and with edges, which, turning a little towards either side, give rise to two strong fasciæ, *i. e.* tendinous membranes, which go from the spine, the one upwards to the upper border of the scapula, the other downwards to the lower border: so that by these strong

* I have met with the accident in practice, and have preparations of the fractured bone, so that there can be no doubt of this accident sometimes occurring, yet it is very rare.

Triangular space.

membranes the scapula is formed into two triangular cavities, and the supra and infra spinatus muscles rise not only from the back of the scapula, and from the sides of its spine, but also from the inner surface of this tense membrane. The spine traverses the whole dorsum, or back of the scapula; it receives the trapezius muscle, that beautiful triangular muscle which covers the neck like a tippet, into its upper edge; whilst from its lower edge a part of the deltoid muscle departs. This spine beginning low at the basis of the scapula, where a certain triangular space may be observed, gradually rises as it advances forwards, till it terminates in that high point or promontory which forms the tip of the shoulder, and overhangs and defends the joint.

Terminates in the acromion.

This high point is named the ACROMION PROCESS. It is the continuation and ending of the spine, which at first rises perpendicularly from the bone, but, by a sort of turn or distortion, it lays its flat side towards the head of the shoulder-bone, and is articulated with the clavicle: here it is hollow, to transmit the supra and infra spinati muscles. At this place, it is thickened, flat, and strong, overhangs and defends the joint, and is not merely a defence, but almost makes a part of the joint itself; for, without this process, the shoulder-bone could not remain a moment in its socket; every slight accident would displace it. The acromion prevents luxation upwards; and is so far a part of the joint, that when it is full under the acromion, the joint is safe; but when we feel a hollow, so that we can push the points of the fingers under the acromion process, the shoulder is luxated, and the socket empty. The point of the acromion forming the apex of the shoulder, a greater projection of this point, and a fulness of the deltoid muscle which arises from it, is a chief cause, and of course a chief mark of superior strength.

Coracoid process.

But there is still another security for the joint; for there arises from the neck of the scapula, almost from the border of the socket, and its inner side, a thick, short, and crooked process, which stands

directly forwards, and is very conspicuous; and which, turning forwards with a crooked and sharp point, somewhat like the beak of a crow, is thence named the CORACOID PROCESS. This also guards and strengthens the joint; though it cannot prevent luxations, it makes them less frequent, and most probably when the arm is luxated inwards, it is by starting over the point of this defending process. This process has three surfaces for the attachment of muscles, and these muscles are, the pectoralis minor, the coraco-brachialis, and the short head of the biceps. Three surfaces on it.

Now the glenoid surface, and these two processes, form the cavity for receiving the shoulder-bone. But still, as if nature could not form a joint at once strong and free, this joint, which performs quick, free, and easy motions, is too superficial to be strong. Yet there is this compensation, that the shoulder-joint, which could not resist, if fairly exposed to shocks and falls, belongs to the scapula, which, sliding easily upon the ribs, yields, and so eludes the force. Falls upon the shoulder do not dislocate the shoulder; that accident almost always happens to us in putting out the hand to save ourselves from falls: it is luxated by a twisting of the arm, not by the force of a direct blow. This bone is subject to be fractured; and then the muscles pull asunder the fractured portions. The acromion is very apt to be broken off by falls on the shoulder, and if the accident be not treated with due attention to the action of the deltoid muscle, permanent lameness is the consequence.

THE CLAVICLE.

The clavicle, or collar-bone, named clavicle from its resemblance to an old-fashioned key, is to the scapula a kind of hinge or axis on which it moves and rolls; so that the free motion of the shoulder is made still freer by the manner of its connection with the breast. Clavicle.

The clavicle is placed at the root of the neck, and at the upper part of the breast: it extends across from the tip of the shoulder to the upper part of the sternum; it is a round bone, a little flattened towards the end which joins the scapula; it is curved like an Italic *ʃ*, having one curve turned out towards the breast; it is useful as an arch supporting the shoulders, preventing them from falling forwards upon the breast, and making the hands strong antagonists to each other, which, without this steadying, they could not have been.

Curve.

It is described by authors in three divisions or parts, viz. the scapular, sternal extremities, and middle portion. The end next the sternum is round and flat, or button-like; the articulating surface is triangular, and is received into a suitable hollow on the upper piece of the sternum. It is not only, like other joints, surrounded by a capsule or purse; it is further provided with a small moveable cartilage, which (like a friction-wheel in machinery) saves the parts, and facilitates the motion, and moves continually as the clavicle rolls. From this inner head there stands out an angle, which, when the clavicles are in their places, gives attachment to the interclavicular ligament; it ties them to the sternum and to each other. The lower surface has a groove in it for the subclavius muscle; the upper surface is marked by the attachment of the clavicular portion of the mastoid muscle, and the insertion of trapezius.

Pars acromialis, sternalis, and media.

Sternal head round.

Groove.

But the outer end of the clavicle is flattened as it approaches the scapula, and the edge of that flatness is turned to the edge of the flattened acromion, so that they touch but in one single point; this outer end of the clavicle, and the corresponding point of the acromion, are flattened and covered with a crust of cartilage; and on the under surface of it, there is a groove corresponding to the groove under the acromion: there is also a small tubercle for a ligament; but the motion here is very slight and quite insensible: they are tied firmly by strong ligaments; and we may consider this as almost a fixed point, for

Scapular head flat.

there is little motion of the scapula upon the clavicle; but there is much motion of the clavicle upon the breast-bone, for the clavicle serves as a shaft or axis, firmly tied to the scapula, upon which the scapula moves and turns, being connected with the trunk only by this single point, viz. the articulation of the clavicle with the breast-bone.

The use of the clavicle being to keep the shoulders apart, it is very obvious that fracture of this bone must be the consequence of falling, as from horse-back, so as to pitch upon the prominence of the shoulder. It is a very common accident, and requires considerable care and management in setting the bone.

HUMERUS.

The OS HUMERI is one of the truest of the cylindrical bones: it is round in the middle; but it appears twisted and flattened towards the lower end; and this flatness makes the elbow-joint a mere hinge, moving only in one direction. It is again regular and round towards the upper end, dilating into a large round head, where the roundness forms a very free and moveable joint, turning easily in all directions. Humerus.

The HEAD of this bone is very large: it is a neat and regular circle; but it is a very small portion of a large circle, so that it is flat; and this flatness of the head, with the shallowness of the glenoid cavity of the scapula, makes it a very weak joint, easily displaced, and nothing equal to the hip-joint for security and strength. Head.

The NECK of this bone cannot fairly be reckoned such; for, as I have explained in speaking of the neck of the thigh-bone, this neck of the humerus, and the necks of most bones (the thigh-bone still excepted), are merely a rough line close upon the head of the bone, without any straitening or intermediate narrowness, which we can properly call a neck. The roughness round the head of the shoulder- Neck. Line for the capsule.

bone is the line into which the capsular ligament is implanted.

Greater tuberosity. The TUBEROSITIES of the os humeri are two small bumps of unequal size, (the one called the greater, the other the smaller, tuberosity of the os humeri,) which stand up at the upper end of the bone, just behind the head: they are not very remarkable. Though infinitely smaller than the trochanter of the thigh-bones, they serve similar uses, viz. receiving the great muscles which move the limb. The GREATER TUBEROSITY is higher towards the outer side of the arm, and receives the supra-spinatus muscle; while the infra-spinatus and teres minor muscles, which come from the lower part of the scapula, are implanted into the same protuberance, but a little lower. Lesser tuberosity. The LESSER TUBEROSITY has a single muscle fixed into it, the subscapularis muscle.

Groove. The two tuberosities form betwixt them a groove, which is pretty deep; and in it the long tendon of the biceps muscle of the arm runs: and as it runs continually, like a rope in the groove of a pully, this groove is covered in the fresh bones with a thin cartilage, smooth, and like the cartilages of joints. Ridges. On the outside of this groove there is a long ridge for the insertion of the pectoralis, on the inside one for the latissimus dorsi. Insertion of the deltoid. On the body of the bone, about one third part of its length from the head, there is an irregularity for the attachment of the deltoid muscle; and on the inside of the bone near its middle, Foramen. is the hole for the nutritious artery.

The os humeri at its lower part changes its form, is flattened and compressed below, and is spread out into a great breadth of two inches or more; where there is formed on each side a sharp projecting point, (named condyle,) for the origin of great muscles; and in the middle, betwixt the two condyles, there is a grooved articulating surface, which forms the hinge of the elbow. At the lower extremity, the bone is somewhat twisted.

Ridges internal and external. At the lower end of the bone there are two ridges, one leading to either condyle, which it is of

some consequence to observe; for the articulation of the humerus and ulna is a mere hinge, the most strictly so of any joint in the body: it has, of course, but two motions, viz. flexion and extension: and there are two muscles, chiefly one for extending, the other for bending the arm: the flexor muscle lies on the fore part, and the extensor on the back part of the arm; and so the whole thickness of the arm is composed at this place of these two muscles and of the bone: but that the fore and back parts of the arm might be thoroughly divided, the bone is flattened betwixt them; and that the division might extend beyond the mere edges of the bone, there are two fasciæ or tendinous webs, which go off from either edge of the humerus, and which continue to divide the fore from the back muscles, giving these muscles a broader origin; they are named, from their office, intermuscular membranes; and this is the meaning of the two ridges which lead to the two condyles.

The two projections in which these edges end, are named CONDYLES. The condyles of the thigh-bone are the broad articulating surfaces by which that bone is joined with the tibia; while the condyles of the shoulder-bone are merely two sharp projecting points for the origin of muscles, which stand out from either side of the joint, but which have no connection with the joint. The chief use of the condyles of the shoulder-bone is to give a favourable origin and longer fulcrum for the muscles of the fore-arm, which arise from these points. The outer tubercle being the smaller one, gives origin to the extensor muscles, where less strength is required. But the inner tubercle is much longer, to give origin to the flexor muscles with which we grasp, which require a bolder and more prominent process to arise from; for greater power is needed to perform such strong actions as grasping, bending, pulling, while the muscles which extend the fingers need no more power than just to antagonise or oppose the

Condyles.

The inner longest, and why.

flexors; their only business being to unfold or open the hand, when we are to renew the grasp.

It is further curious to observe, that the inner tubercle is also lower than the other, so that the articulating surface for the elbow-joint is oblique, which makes the hand fall naturally towards the face and breast, so that by being folded merely without any turning of the os humeri, the hands are laid across.

Trochlea. The articulating surface which stands betwixt these condyles, forms a more strict and limited hinge than can be easily conceived, before we explain the other parts of the joint. The joint consists of two surfaces; first, a smooth surface, upon which the ulna moves as on a hinge; and secondly, of a small knob upon the outside of the trochlea, which has a neat round surface, upon which the face or socket belonging to the button-like end of the radius rolls. These two surfaces are called, the one the small head, and the other the cartilaginous pully, or trochlea, of the humerus.

Knob for the head of the radius.

Belonging to the joint, and within its capsular ligament, there are two deep hollows, which receive certain processes of the bones of the fore-arm. One deep hollow on the fore part of the humerus, and just above its articulating pully, receives the horn-like or coronoid process of the ulna, viz. fossa coronoidea; the other receives the olecranon, or that process of the ulna which forms the point of the elbow, viz. fossa olecranalis.

Fossa for the coronoid process.

Fossa for the olecranon.

RADIUS AND ULNA.

The radius and ulna are the two bones of the fore-arm. The radius, named from its resemblance to the ray or spoke of a wheel; the ulna, from its being often used as a measure. The radius belongs more peculiarly to the wrist, being the bone which is chiefly connected with the hand, and which turns along with it in all its rotatory motions: the ulna,

again, belongs more strictly to the elbow-joint, for by it we perform all the actions of bending or extending the arm.

Ulna. The ULNA is in general of a triangular or prismatic form, like the tibia, and the elbow is formed by the ulna alone; for there is a very deep notch or hinge-like surface, which seems as if it had been moulded upon the lower end of the humerus, embraces it very closely, and takes so sure a hold upon the humerus, that it allows not the smallest degree of lateral motion, and almost keeps its place in the dry skeleton, without the help of ligaments or muscles; it presents, in profile, somewhat of the shape of the letter ς of the Greek, and therefore is named the SIGMOID CAVITY of the ulna. Sigmoid cavity. But this sigmoid cavity were a very imperfect hinge without the two processes by which it is guarded before and behind; the chief of these is the OLECRANON, or large bump, Olecranon. which forms the extreme point upon which we rest the elbow. It is a big and strong process, which, fitting into a deep hollow on the back of the humerus, serves two curious purposes; it serves as a long lever for the muscles which extend or make straight the fore-arm; and when by the arm being extended, it checks into its place, it takes so firm a hold upon the hinge or joint of the os humeri, as to secure the joint in pulling, and such other actions as might cause a luxation forwards. The other process which guards the elbow-joint is named the CORONOID PROCESS, Coronoid process. from its horn or pointed form: it stands up perpendicularly from the upper or fore part of the bone; it forms the fore part of the sigmoid cavity, and completes the hinge. Tubercle. On the root of the coronoid process there is a rough tubercle for the attachment of the brachialis internus. The coronoid process is useful, like the olecranon, in giving a fair hold and larger lever to the muscles, and to secure the joint; for the arm being extended, as in pulling, the olecranon checks into its place, and prevents luxation forwards: and the arm again being bent, as in striking, pushing, or saving ourselves from falls, the coronoid

process prevents luxation backwards; so the joint consists of the olecranon and the coronoid process as the two guards, and of the sigmoid cavity or hollow of articulation betwixt them. But the smaller or upper head of the radius also enters into the joint, and lying upon the inner side of the coronoid process, it makes a small hollow there in which it rolls; and this second hollow, touching the edge of the sigmoid cavity, forms a double sigmoid cavity, of which the first, or GREATER SIGMOID CAVITY, is for receiving the lower end of the humerus; and the second or LESSER SIGMOID CAVITY, for receiving the upper head of the radius. Betwixt these there is a pit for receiving the glandular apparatus of the joint. The form of the bone being prismatic, or triangular, it has, like the tibia, three ridges, one of which is turned towards a corresponding ridge in the radius, and betwixt them the interosseous ligament is stretched; and this interosseous ligament fills all the arch or open space betwixt the radius and ulna, and saves the necessity of much bone; gives as firm an origin to the muscles as bone could have done, and binds the bones of the fore-arm together so strongly, that though the ulna belongs entirely to the elbow-joint, and the radius as entirely to the wrist, they have seldom been known to depart from each other. On the outside of the greater extremity of the ulna, there is a triangular surface for the attachment of the anconeus muscle. The ulna, bigger at the elbow, grows gradually smaller downwards, till it terminates almost in a point. It ends below in a small round head, which is named the LOWER HEAD of the ulna, which scarcely enters into the joint of the wrist; but being received into a hollow on the side of the radius, the radius turns upon the lower head of the ulna, like an axis or spoke.

Greater sigmoid. Lesser sigmoid cavities. Pit. Form prismatic. Ligament. Triangular surface. Lower head.

Below this little head, the bone ends towards the side of the little finger in a small rounded point, which is named the STYLOID PROCESS of the ulna; it is chiefly useful in giving a strong adhesion to the ligament which secures the wrist there. And as

Styloid process.

the styloid process and the olecranon, the two extremities of the ulna, are easily and distinctly felt, the length of this bone has been used as a measure; and so it was named cubitus by the ancients, and is named ulna by us.

RADIUS.

The radius is the second bone of the fore-arm, and has its position exactly reversed with that of the ulna: for the ulna, belonging to the elbow, has its greater end upwards; the radius, belonging to the wrist, has its greater end downwards; and while the ulna only bends the arm, the radius carries the wrist with a rotatory motion, and so entirely belongs to the wrist, that it is called the manubrium manus, as if the handle of the hand. Radius: Position.

The BODY of the radius is larger than that of the ulna. The transverse strength of the arm depends more upon the radius, which has more body and thickness, is more squared, and is arched in some degree so as to stand off from the ulna, without approaching it, or compressing the other parts. The radius lies along the outer edge of the fore-arm, next to the thumb; and being, like the ulna, of a prismatic or triangular form, it has one of its angles or edges turned towards the ulna to receive the interosseous ligament. Form of the body.

The UPPER HEAD of the radius is smaller, of a round, flattish, and button-like shape, and lies so upon the lower end of the humerus, and upon the coronoid process of the ulna, that it is articulated with both bones; for, 1st, The hollow of its head is directly opposed to the outer condyle of the os humeri; and, 2dly, The flat side of its button-like head rubs and turns upon the side of the coronoid process, making a socket there, which is called the lesser sigmoid cavity of the ulna. Upper head smaller. Hollow.

Immediately below the round flat head is a narrowness or straitening, called the NECK of the radius; round this neck there is a collar or circular Neck.

ligament, (named the coronary ligament of the radius,) which keeps the bone securely in its place, turning in this ligamentous band like a spindle in its bush or socket; for the radius has two motions, first, accompanying the ulna in its movements of flexion and extension; and, secondly, its own peculiar rotation, in which it is not accompanied in return by the ulna; but the ulna continuing steady, the radius moves and turns the wrist.

Immediately under this neck, and just below the collar of the bone, there is a prominent bump, like a flat button, soldered upon the side of the bone, which is the point into which the biceps flexor cubiti, the most powerful flexor muscle of the fore-arm, is inserted. On the outside of the bone, and near the middle, there is a roughness for the insertion of the pronator teres. Where the face of the radius is towards the ulna, there is a long sharp spine for the attachment of the interosseous ligament.

Tubercle. Roughness. Spine.

The upper head is exceedingly small and round; while the LOWER HEAD swells out, broad and flat, to receive the bones of the wrist. There are two greater bones in the wrist, the scaphoides and lunare, which form a large ball, and this ball is received into the lower end of the radius: the impression which these two bones make there is pretty deep, and somewhat of a boat-like shape; whence it is called (like the articulating surface of the tibia) the scaphoid cavity of the radius: it is sometimes partially divided by a ridge; and on the edge of the radius, next to the thumb, the bone ends in a sort of peak or sharper point, which is named, (though with very little meaning,) the STYLOID PROCESS of the radius.

Lower head. Scaphoid cavity. Styloid process.

So the scaphoid cavity of the radius forms the joint with the wrist; but there is another small cavity, on the side of the radius, near to the little head of the ulna, into which the lesser head of the ulna is received, and this is enclosed in a proper and distinct capsule. The little head of the ulna does not descend so low as to have any share in forming the wrist.

There are properly two distinct joints: the great joint of the wrist, moving upon the radius; the other a little joint within this, of the radius rolling upon the ulna, and carrying the wrist along with it. On the outside of the extremity of the radius, we find a ridge, in the grooves on the sides of this ridge the extensor tendons run. The extensors of the thumb also make impressions. On the inside of the head of the bone, there is a flattened surface for the lodgment of the pronator quadratus muscle; and a sharp line for its insertion. Ridge and grooves.

OF THE HAND AND FINGERS.

The wrist is the most complex part of all the bony system, and is best explained in a general way, by marking the three divisions of the hand, into — the carpus, or wrist bones; the metacarpus, or bones that stand upon the wrist; and the fingers, consisting each of three joints. 1. The carpus, or wrist, is a congeries of eight small bones, grouped together into a very narrow space, very firmly tied together by cross ligaments, making a sort of ball or nucleus, a solid foundation, or centre, for the rest of the hand. 2. The metacarpus is formed of five long bones, founded upon the carpal bones, and which, departing from that centre in somewhat of a radiated form, give, by their size and strength, a firm support to each individual finger, and by their radiated or spoke-like form, allow the fingers free play. 3. The fingers, consisting each of three very moveable joints, are set free upon the metacarpus, so as to show a curious gradation of motion in all these parts; for the carpal bones are grouped together into a small nucleus, firm, almost immoveable, and like the nave of a wheel; then the metacarpal bones founded upon this are placed like the spokes of the wheel, and having a freer motion; and, lastly, the fingers, by the advantage of this radiated form in the bones upon which they are placed, move very nimbly, and have a rotatory as well as a hinge-like motion: so that the

Carpus.

Metacarpus.

Fingers.

motion is graduated and proportioned in each division of the hand; and even where there is no motion, as in the carpus, there is an elasticity, which, by gentle bendings, accommodates itself to the more moveable parts.

Carpus. The CARPUS, or wrist. — Looking upon the external surface of the carpus, we count eight small bones disposed in two rows, with one bone only a little removed from its rank; and we observe that the whole is arched outwards, to resist injuries, and to give strength; and that the bones lie like a pavement, or like the stones of an arch, with their broader

Form. ends turned outwards. On the internal surface, again, we find the number of bones not so easily counted; for their smaller ends are turned towards the palm of the hand, which being a concave surface, the narrow ends of the wedges are seen huddled together in a less regular form, crowded, and lapped over each other; but in this hollow, the four corner bones are more remarkable, projecting towards the palm of the hand, so as to be named processes; and they do indeed perform the office of processes; for there arises from the four corner points a strong cross ligament, which binds the tendons down, and makes under it a smooth floor or gutter for them to run in.

The individual bones of the carpus are small, cornered, and very irregular bones, so that their names do but very poorly represent their form. To describe them without some help of drawing, or demonstration, is so very absurd, that a description of each of them seems more like a riddle, than like a serious lesson: it cannot be understood, and indeed it need hardly be remembered; for all that is useful, is but to remember the connection and place, and the particular uses of each bone: in reading of which, the student should continually return to the plates, or he must have the bones always in his hand.

1. ROW FORMING THE WRIST: VIZ.

OS SCAPHOIDES, LUNARE, CUNEIFORME, PISIFORME.

Os scaphoides. — The boat-like bone. This name of boat-like bone, or boat-like cavity, has been always a favourite name, though a very unmeaning one. The scaphoid bone is worthy of notice, not merely from its being the largest bone, but also as it forms a chief part of the joint of the wrist; for it is this bone which is received into the scaphoid cavity of the radius: it is a very irregular bone, in which we need remember only these points, — the large round surface covered with cartilage, smooth, and answering to the cavity in the head of the radius; the hook-like or projecting process, which forms one of the corner points of the carpus, and gives a hold to one corner of the ligament which binds down the tendons of the wrist. There is also a furrow for the capsular ligament, the concavity from which this bone takes its name, and by which it is articulated with the trapezium and trapezoides; and on its inner surface an oval cavity for the os magnum.

Os scaphoides. Received into the scaphoid cavity of the radius. The process. Concavity.

The os lunare is named from one of its sides being somewhat of the shape of a half moon; it is next in size to the scaphoid bone, and is equal to it in importance; for they are joined together, to be articulated with the radius. This bone takes an equal share in the joint with the scaphoid bone; and, together, they form a great ball, fitting the socket of the radius, and of a long form: so that the wrist is a proper hinge. The chief marks of this bone are, its greater size, its lunated edge, and its round head forming the ball of the wrist-joint. These are its surfaces:

Os lunare.

1. The surface of a semilunar shape, and, on the radial side, attached to the last bone. 2. The convex surface for articulation with the radius. 3. The ulnar surface for articulation with the os cuneiforme.

Surfaces.

4. The hollow surface for articulation with the os magnum, the central bone of the second row.

Os cuneiforme. The os CUNEIFORME, or wedge-like bone, is named rather perhaps from its situation, locked in among the other bones, than strictly from its form. Its side forming the convex of the hand is broader; its point towards the palm of the hand is narrower: and so far, we may say, it is a wedge-like bone; but it is chiefly so from its situation, closely wedged in betwixt the lunare and pisiform bones.

Surfaces. 1. We may readily distinguish the surface articulated with the os lunare. 2. Opposite to this the surface of attachment of the os pisiforme. 3. The further surface, that is, the side most remote from the fore-arm, is articulated with the unciforme; a loose cartilage is interposed betwixt this bone and the end of the ulna.

Os pisiforme. The os PISIFORME is a small, neat, and round bone, named sometimes ORBICULAR, or round bone, but oftener pisiform, from its resemblance to a pea. One surface of articulation. It is placed upon the cuneiform bone, and it stands off from the rest into the palm of the hand, so as to be the most prominent of all the corner bones; of course, it forms one of the corner points or pillars of that arch under which the tendons pass. The pisiform bone is a little out of its rank, is very moveable, and projects so into the palm as to be felt outwardly, just at the end of the styloid process of the ulna; it can be easily moved and rolled about, and is the point into which the ligament of the wrist is implanted; the flexor carpi ulnaris, one of the strong muscles for bending the wrist, is inserted into it.

2. ROW SUPPORTING THE METACARPAL BONES: VIZ.

OS TRAPEZIUM, TRAPEZOIDES, MAGNUM, ET UNCIFORME.

Trapezium. The second row begins with the TRAPEZIUM, a pretty large bone, which, from its name, we should

expect to find of a regular squared form; while it has, in fact, the most irregular form of all, especially when detached from the other bones. The chief parts to be remarked in the bone, are the great socket, or rather the trochlea for the thumb; and as the thumb stands off from one side of the hand, this socket is rather on one side. There is also a little process which makes one of the corner points, and stands opposite to the hook of the unciforme.

Irregular.

Surfaces of articulation.

Opposite to the surface of articulation with the thumb, and towards the first row, there is a semilunar surface which touches the convexity of the scaphoides, and another which articulates with the trapezoides. The fourth articulating surface of this bone is opposed to the head of the metacarpal bone of the finger.

The TRAPEZOIDES is next to the trapezium, is somewhat like the trapezium, from which it has its name. It also resembles the cuneiform bone of the first row in its shape and size, and in its being jammed in betwixt the two adjoining bones.

Trapezoides.

It is articulated by its nearer surface to the scaphoides; on its further surface, by two planes, to the metacarpal bone of the fore finger; on the radial surface, to the trapezium; and on the ulnar surface, to the os magnum; having thus five planes or surfaces.

Five planes or articulating surfaces.

The OS MAGNUM is named from its great size; not that it is the largest of all, nor even the largest bone of the second row, for the unciform bone is as big; but there is no other circumstance by which it is well distinguished. It is placed in the centre of the upper row; has a long round head, which is jointed with the socket formed of the os lunare and scaphoides: on the radial surface the magnum is articulated with the trapezoides; on the ulnar surface with the unciform; on the further surface it has three planes, and receives the whole head of the metacarpal of the middle finger, and part of the metacarpal of the fore finger and of the ring finger.

Os magnum.

The OS UNCIFORME, or hook-like bone, is named from a flat hook-like process, which projects to-

Os unciforme.

wards the palm of the hand. This is one of the corner bones; and standing in the end of the row, it is wedged betwixt the os magnum of its own row, and the os lunare and cuneiforme of the first row,

Insituation and its process.

It is large and squared; but the thing chiefly remarkable is that process from which it takes its name; a long and flat process of firm bone, unciform, or hook-like, and projecting far into the palm of the hand, which being the last and highest of the corner points, gives a very firm origin to the great ligament by which the tendons of the wrist are bound down. On its further surface, it has two articulating surfaces corresponding with the metacarpal bones of the ring and middle fingers.

Their connections.

All these bones of the carpus, where they are joined to each other, are covered with a smooth articulating cartilage, are bound to each other by all forms of cross ligaments, and are consolidated, as it were, into one great joint. They are in general so firm as to be scarcely liable to luxation; and although one only is called cuneiform, they are all somewhat of the wedge-like form, with their broader ends outwards, and their smaller ends turned towards the palm of the hand; they are like stones in an arch, so that no weight nor force can beat them in; if any force do prevail, it can beat others in only by forcing one out. A bone starting outwards, and projecting upon the back of the hand, is the only form of luxation among these bones, and is extremely rare. *

Four metacarpal bones.

METACARPUS. — The metacarpus is composed of four bones, upon which the fingers are founded.

* Late years have presented to me a subluxation of the centre bones of the first row, which generally ends in considerable obliquity of the hand, or distortion of the wrist. The boy that played the dragon in the pantomime at Covent-Garden, fell upon his hands, owing to the breaking of the wire that suspended him in his flight, and he suffered this accident in both his wrists. These bones, and their ligaments, are subject to scrofulous inflammation.

They are big, strong bones, brought close together at the root, but wider above; for the lower heads are small and flat, and grouped very closely together, to meet the carpal bones. But they swell out at their upper ends into big round heads, which keep the bones much apart from each other. Nothing of importance can be said concerning the individual bones. To speak of them individually is a mere waste of time. We may observe of the metacarpal bones in general: 1. That their nearer heads, being flat and squared, gives them a firm implantation upon their centre or nucleus, the carpus; and they have scarcely any freer motion upon the carpal bones, than the carpal bones have upon each other.

Their nearer head square.

2. Their further heads are broader, whereby the articulating parts of the bone are kept apart, which gives freedom to the lateral motions of the bones of the fingers.

Their further head round and free.

3. Each metacarpal bone is slightly bent; 4. and being smaller in the middle, there is a space left betwixt the bones for the lodgment of the interossei muscles, and they have ridges which mark the place of attachment of the interossei muscles.

They diverge somewhat.

Ridges.

5. These bones taken collectively still preserve the arched form of the carpal bones, being, with the carpal bones, convex outwardly, and concave inwardly, to form the hollow of the hand; and though they have little motion of flexion or extension, they bend towards a centre, so as to approach each other, increasing the hollowness of the hand, to form what is called Diogenes's cup.

They are arched.

6. The articulating heads of the further extremities of these bones are flattened, or somewhat grooved, for the play of the tendons of the interossei muscles; and small processes stand out laterally for the attachment of ligaments, like little condyles.

Condyles.

It is farther necessary to observe, into how small a space the carpal bones are compressed, how great a share of the hand the metacarpal bones form, and how far down they go into the hollow of the hand; for I have seen a surgeon, who, not having the smallest suspicion that their lower ends were so near the

wrist as they really are, has, in place of cutting the bone neatly in its articulation with the carpus, broken it, or tried to cut it across in the middle.

FINGERS.—We commonly say, that there are five metacarpal bones; in which reckoning we count the thumb with the rest: but what is called the metacarpal of the thumb is properly the first phalanx, or the first proper bone of the thumb, so that the thumb, regularly described, has, like the other fingers, three joints, and no metacarpal bone.

THUMB.—The first bone of the thumb resembles the metacarpal bones in size and strength, but it differs widely in being set upon the carpus, with a large and round head; it being set off from the line of the other fingers, standing out on one side, and directly opposed to them; it rolls widely and freely: it is opposed to the other fingers in grasping, and, from its very superior strength, the thumb is named pollex, from pollere; and the peculiar shape of the articulating extremities, and the lateral processes or condyles are, as it were, better characterized than in the bones of the fingers.

The FINGERS have each of them three bones:—These bones are gently arched, uniform, and convex upon their outer surface, grooved within for the lodgment of the stronger flexor tendons. 1. The first bone is articulated with the metacarpal bones by a ball and socket; the socket, or hollow on the lower part of the first finger-bone, being set down upon the large round head of the metacarpal bone. 2. The second and third joints of the fingers are gradually smaller, and though their forms do a good deal resemble the first joint, they are more limited in their motions; and are strictly hinge joints. 3. Here, as in other hinge joints, there are strong lateral ligaments, and lateral processes or condyles, for their attachment. When these lateral ligaments are burst or cut, the finger turns in any direction; so that the motions of the fingers are limited rather by their lateral ligaments, than by any thing peculiar

in the forms of the bones. 4. The face of each finger-bone is grooved, so that the tendons, passing in the palm of the hand, run upwards along this groove or flatness of the fingers; and from either edge of this flatness there rises a ligament of a bridge-like form, which covers the tendons like a sheath, and converts the groove into a complete canal. 5. The last joint or phalanx of each finger is flattened, rough, and drawn smaller gradually towards the point of the finger; and it is to this roughness that the skin and nail adhere at the point.

OF THE SKULL IN GENERAL:

THE BONES OF WHICH IT IS COMPOSED — THEIR TABLES — DIPLOE — SUTURES — THEIR ORIGINAL CONDITION, AND THEIR PERFECT FORM REPRESENTED AND EXPLAINED.

While the bones in general serve as a basis of the soft parts, for supporting and directing the motions of the body, certain bones have a higher use in containing those organs whose offices are the most essential to life. The skull defends the brain; the ribs and sternum defend the heart and lungs; the spine contains that prolongation of the brain which gives out nerves to all the body: and the injuries of each of these are important in proportion to the value of those parts which they contain.

How much the student is interested in obtaining a correct and perfect knowledge of the skull he must learn by slow degrees. For the anatomy of the skull is not important in itself only; it provides for a more accurate knowledge of the brain; explains, in some degree, the organs of sense; instructs us in all those accidents of the head which are so often fatal, and so often require the boldest

H 2

of all our operations. The marks which we take of the skull, record the entrance of arteries; the exit of veins and nerves; the places and uses of those muscles which move the jaws, the throat, the spine. Indeed, in all the human body, there is not found so complicated and difficult a study as this anatomy of the head; and if this fatiguing study can be at all relieved, it must be by first establishing a very regular and orderly demonstration of the skull.

For this end, we distinguish the face, where the irregular surface is composed of many small bones from the cranium or proper skull, where a few broad and flat-shaped bones form the covering of the brain. It is these chiefly which enclose and defend the brain, which are exposed to injuries, and are the subject of operation. It is these also that transmit the nerves: so that the cranium is equally the object of attention with the physiologist and with the surgeon.

All the bones of the cranium are of a flattened form, consisting of two tables, and an intermediate diploe, which corresponds to the cancelli of other bones. The tables of the skull are two flat and even plates of bone: the external is thought to be thicker, more spongy, less easily broken; the inner table, again, is dense, thin, and brittle, very easily broken, and is sometimes fractured, while the external table remains entire: thence it is named tabula vitrea, or the glassy table. These tables are a little parted from each other*; and this space is filled up with the diploe, or cancelli. The cancelli, or lattice-work, have membranes, covered with vessels, partly for secreting marrow, and partly for nourishing the bone; and by the dura mater adhering to the internal surface, and sending in arteries, which enter into the cancelli by passing through

* In anatomy, there is occasion, in almost every description, for a scale of smaller parts. The French divided their inch into twelve parts, each of which is a line. The French line, or twelfth of an inch, is a measure which I shall often have occasion to use.

the substance of the bone, and by the pericranium covering the external plate, and giving vessels from without, which also enter into the bone, the whole is connected into one system of vessels. The pericranium, dura mater, and skull depend so entirely one upon the other, and are so fairly parts of the same system of vessels, that an injury of the pericranium spoils the bone, separates the dura mater, and causes effusion upon the brain: a separation of the dura mater is, in like manner, followed by separation of the pericranium, which had been sound and unhurt; and every disease of the cancelli, or substance of the bone, is communicated both ways; inward to the brain, so as to occasion very imminent danger; outwards towards the integuments, so as to warn us that there is disease. The general thickness of the skull, and the natural order of two tables, and an intermediate diploe, is very regular, in all the upper parts of the head. In perforating with the trepan, we first cut, with more labour, through the external table; when we arrive at the cancelli, there is less resistance, the instrument moves with ease, there is a change of sound, and blood comes from the tearing of these vessels, which run in the cancelli, betwixt the tables of the skull. Surgeons thought themselves so well assured of these marks, that it became a rule to cut freely and quickly through the outer table, to expect the change of sound, and the flow of blood, as marks of having reached the cancelli, and then to cut more deliberately and slowly through the inner table of the skull. But this shows an indiscreet hurry, and unpardonable rashness in operation. The patient, during this sawing of the skull, is suffering neither danger nor pain, unless when the bone is inflamed; and many additional reasons lead us to refuse altogether this rule of practice: for the skull of a child consists properly of one table only; or the tables are not yet distinguished, nor the cancelli formed: in youth, the skull has its proper arrangement of can-

celli and tables; but still, with such irregularities and exceptions, as make a hurried operation unsafe: in old age, the skull declines towards its original condition, the cancelli are obliterated, the tables approach each other, or are closed and condensed into one; the skull becomes irregularly thick at some points, and at others thin, or almost transparent; so that there can hardly be named any period of life in which this operation may be performed quickly and safely at once. But, besides this gradual progress of a bone increasing in thickness and regularity as life advances, and growing irregular and thinner in the decline of life, we find dangerous irregularities in skulls of all ages. The author had specimens in his possession where the thickness of the skull-cap varied from nearly an inch to the thinness of common paper. There are often at uncertain distances, upon the internal surface of the skull, hollows and defects of the internal table, deep pits, or foveæ, as they are called. These foveæ increase in size and in number as we decline in life: they are more frequent on the inner surfaces of the parietal and frontal bones; so that in those places where the skull should be most regular, we are never sure, and must, even in places considered to be the safest, perforate gradually and slowly. Let the reader pursue this subject under the title of THE FORMATION AND GROWTH OF BONES.

The BONES of the skull are divided into those of the cranium; the bones of the face; and common or intermediate bones.*

* The head is divided into the cranium and face. For the *cranium* we find in old authors the words *calea* or *calvaria*, from calvus, bald, or sometimes *cerebri galea*, as being like a helmet to protect the brain.

We find some terms distinguishing certain parts of the cranium, as *glabella*, the smooth part in the centre and lower part of the forehead; *occiput*, the utmost convexity of the head backward; *vertex*, the crown of the head where the hairs turn; *bregma*, or *fontanelle*, which are terms derived from very false notions, but

The following is the usual division of the bones of the head :—

In the adult head there are thirty bones and thirty-two teeth.

Of the Cranium, Six Bones.	Intermediate or Common Bones, Two.	Bones of the Face, Fourteen.
1 Os Frontis	1 Os Sphenoides	2 Ossa Maxillaria Supra
2 Ossa Parietalia or Bregmatis	1 Os Æthmoides	2 Ossa Malarum
2 Ossa Temporalia		2 Ossa Nasi
1 Os Occipitis		2 Ossa Palati
		2 Ossa Unguis vel Lachrymalia
		2 Ossa Turbinata Infra
		1 Vomer
		1 Maxilla Inferior

Bones of the Ear, Four on each Side, viz.	Teeth.
	In the child twenty.
Malleus	*In the adult* thirty-two, viz.
Incus	8 Incisores
Os Orbiculare	4 Cuspidati
Stapes	8 Bicuspides
	12 Molares.

We see, therefore, that the bones of which the cranium, or skull, is formed, by which the brain is surrounded and protected, are in all eight in number. 1. The FRONTAL BONE, or bone of the forehead, forms the upper and fore part of the head,—extends a little towards the temples, and forms also the upper part of the socket for the eye. 2, 3. The PARIETAL BONES are the two large and flat bones which form all the sides and upper part of the head; and are named parietalia, as they are the walls or sides of the cranium. 4. The OS OCCIPITIS is named from its forming all the occiput or back of the head, though much of this bone lies in the neck, and is hidden in the basis of the skull. 5, 6. The OSSA TEM-

which mean the interstices left in a child's skull betwixt the cranial bones.

The student ought to know these terms, but good taste rejects them even from medical language, when the description can be given in plain English.

FORALIA form the lower parts of the sides of the cranium: they are called temporal, from the hair that covers them being the first to turn grey, marking the time of life. 7. The OS ÆTHMOIDES, and 8. the OS SPHENOIDES, are quite hidden in the basis of the skull: they are very irregular, and very difficultly described or explained. The OS ÆTHMOIDES is a small square bone, hollow, and with many cells in it: it hangs over the nose, and constitutes a great and important part of that organ, and at the same time supports the brain. The olfactory nerves, by passing through it at many points, perforate it like a sieve; and it takes its name from this perforated or æthmoid plate. The OS SPHENOIDES is larger and more irregular still; placed further back; locked in betwixt the occipital and æthmoidal bones; lies over the top of the throat, so that its processes form the back of the nostrils, and roof of the mouth; and it is so placed, as to support the very centre of the brain, and transmit almost all its nerves.*

OF THE SUTURES OF THE SKULL.

The joinings of the bones being indented and irregular, and like seams, they are called sutures.

1. The CORONAL SUTURE is that which joins the frontal to the parietal bones; extends almost directly across the head, from ear to ear; descends behind the eye, into the deep part of the temple; and there, losing its serrated appearance, becomes like the squamous or scaly suture, which joins the temporal bones. It is named coronal, because the ancients wore their garlands on this part of the head. But the suture had been better entitled to this name, had it surrounded the head, than as it crosses it.

* Some foreign authors, as if it were to make a complex piece of anatomy still more complicated, describe the sphenoid and occipital bone as one, calling it *os spheno-occipitale*, or *os basilare*.

2. The LAMBDOIDAL SUTURE is that one which joins the parietal bones to the occipital bone. It begins behind one ear, ascends and arches over the occiput, descends behind the other ear. It thus strides over the occiput, in a form somewhat resembling the letter lambda (Λ) of the Greeks, whence its name.

3. The SAGITTAL SUTURE joins the parietal bones to each other; runs on the very top of the head; extends forwards from the lambdoid suture till it touches, or sometimes passes, the coronal suture; and from lying betwixt these two sutures, like an arrow betwixt the string and the bow, it has been named sagittal.

4. The TEMPORAL or SQUAMOUS SUTURES join the temporal bones to the parietal, occipital, and frontal bones; the sphenoid bone also enters into the temporal suture, just behind the eye. The temporal suture makes an arch corresponding almost with the arch of the external ear; it meets the coronal suture an inch before the ear, and the lambdoidal an inch behind it. This back part belongs as much to the occipital as to the temporal bone; and so has been named, sometimes additamentum suturæ lambdoidalis, sometimes additamentum suturæ squamosæ: for this temporal suture is, on account of the edge of the temporal and occipital bones being thin, and like scales of armour laid over each other, often named the squamous or scaly suture.

5. The SPHENOIDAL and ÆTHMOIDAL SUTURES are those which surround the many irregular processes of these two bones, and join them to each other, and to the rest.

6. The TRANSVERSE SUTURE is one which, running across the face, and sinking down into the orbits, joins the bones of the skull to the bones of the face; but with so many irregularities and interruptions, that the student will hardly recognise this as a suture.

7. The ZYGOMATIC SUTURE is one which joins a branch of the temporal bone to a process of the cheek bone; forming an arch, zygoma, or yoke:

but this suture has not extent; it has a serrated appearance at one single point only.

To mark and know these sutures, and to be able to trace them in imagination upon the naked head, to foresee where a suture will present, and how far it runs, may be a matter of great importance to the surgeon. Hippocrates, who has had more to praise his honesty than to follow his example, acknowledges his having mistaken a suture for a fracture of the skull; and since this warning, various contrivances and marks have been thought of, for preventing the like mistake. It may be useful to remember, that the suture has its serræ or indentations, is firmly covered by the pericranium, is close, and does not bleed: but that a fissure, or fracture of the skull, runs in one direct line, is larger and broader at the place of the injury, and grows smaller, as you recede from that, till it vanishes by its smallness; and that it always bleeds. Indeed the older surgeons, observing this, poured ink upon the suspected part, which, if the skull was hurt, sunk into the fissure, and made it black and visible; but left the suture untouched.* The old surgeons, or rather the ancient doctors, directed to make the patient take a wire betwixt his teeth, which being struck like the spring of an instrument, he would feel the twang produce a painful and particular sensation in the fractured part of the head. But after all these observations, in place of any true and certain marks, we find a number of accidents which may lead us into a mistake.

Sutures cannot be distinguished by their serræ or teeth; for the temporal sutures want this common character, and rather resemble capillary fractures of the skull †; nor even by their places, for we know that there are often insulated bones (ossa Wormiana)

* In matter of fact, the blood serves this purpose by its sinking into the fissure, and giving it a dark appearance. There is a roughness on the edge of the fissure, which, being felt by means of the probe, will distinguish the fissure from the suture.

† Viz. Fractures as small as a hair, thence named capillary.

surrounded with peculiar joinings, which so derange the course of the common sutures, that the joinings may be mistaken for fractures of the skull, and the ossa Wormiana for broken parts. Sometimes the squamous suture is double, with a large arch of bone intercepted betwixt the true and the false suture; or the sagittal suture, descending beyond its usual extent, and quite to the nose, has been mistaken for a fracture, and trepanned; and oftener in older skulls, the sutures are entirely obliterated all over the head. If the surgeon should pour ink upon the skull, he would have reason to be ashamed of an experiment so awkward and unsuccessful; and for the old contrivance of a wire or cord held in the mouth, it cannot be done, since the patient is commonly insensible; and even, though less hurt, his feelings, after such an accident, must be very confused; he must be too liable to be deceived: and we cannot, on such slender evidence as this, perform so cruel an operation as cutting up the scalp, or so dangerous a one as the trepan.

For various reasons, we are careful to trace the bones from their original soft and gristly or membraneous state, to their perfect condition of hard bone: and most of all, we are concerned to do so in the head, where, in childhood, the appearances are not singular and curious only, but have always been supposed to indicate some wise and useful purpose. It is in this original condition of the soft and growing bones, that anatomists have sought to find a theory of the sutures, how they are formed, and for what uses. It has been remarked, that the number of pieces in the skull is infinitely greater in the child than in the man. These bones, ossifying from their centre towards their circumference, it happens, of course, that the fibres are close at the centre of ossification, and are more scattered at the extremities of the bone; when these scattered fibres of opposite bones meet, the growing fibres of one bone shoot into the interstices of that which is opposed: the fibres still push onwards, till

they are stopped at last, and the perfect suture, or serrated line of union is formed.

In dilating this proposition, we should observe, that in the child the bones in the head are membraneous and imperfect. The membraneous interstices begin to be obliterated; the sutures are beginning to close; the distinction of two tables is not yet established; the cancelli are not yet interposed between the plates; the sinuses or caverns of the bones, as in the forehead, the nose, and the jaw, are not formed; and each bone is not only incomplete towards its edges and sutures, but consists often of many parts. The OS FRONTIS is formed of two pieces, which meet by a membraneous union in the middle of the bone. The OSSA PARIETALIA have one great and prominent point of ossification in the very centre of each, from which diverging rays of ossification extend towards the edges of the bone. The OS OCCIPITIS is formed in four distinct pieces: and the TEMPORAL BONES are so fairly divided into two, that their parts retain in the adult the distinct names of petrous and squamous bones. Although these are all the regular points of ossification, yet sometimes there occur small and distinct points, which form irregular bones, uncertain in number or size, found chiefly in the lambdoid suture, sometimes numerous and small, more commonly they are few in number, and sometimes of the full size of a crown, always distorting more or less the course of the suture, and being thus a subject of caution to the surgeon: these are named OSSA TRIQUETRA or TRIANGULARIA, from their angular shape, or WORMIANA, from Olaus Wormius, who remarked them first. Now the os frontis being formed into two larger pieces, their edges meet early in life, and they form a suture; but the bones continuing to grow, their opposite points force deeper and deeper into each other, till at last the suture is entirely obliterated, and the bones unite; and so this suture is found always in the child, seldom in

the adult, almost never in old age. The occipital bones have four parts, they are close upon each other, they meet early, are soon united; and, although very distinct in the child, no middle suture has ever been found in the adult, but always the four pieces are united into one firm and perfect bone. The parietal bones have their rays most of all scattered; the rays of ossification run out to a great distance, and diverge from one single point, so that at their edges they are extremely loose, and they never fail to form sutures by admitting into their interstices the points and edges of the adjoining bones. The surest and most constant sutures are those formed by the edges of the parietal bones; the sagittal in the middle, the coronal over the forehead, the lambdoidal behind, and the squamous suture, formed by their lower edges.

But another phenomenon is supposed to result at the same time, from this meeting and opposition of the fibres and interstices of the growing bones: that when the opposite fibres meet too early, they are not fairly admitted into the open spaces of the opposite bone; but the fibres of each bone being directly opposed point to point, they both turn inwards, and form a ridge or spine, such as is seen on the inner surfaces of the frontal and occipital bones. Such is the common theory, which I suspect is imperfect, and which should be received with some reserve, for all the phenomena are not yet explained; we find each suture always in its appointed place; we find nothing like a suture formed betwixt the head and body of a long bone, though they are formed in distinct points, and are not united till after the years of manhood; we find no sutures when bones are broken and reunited, when they have been spoiled, and are replaced, when a piece of spoiled bone has been cut away, nor when a new shaft of a bone is formed by the secreting vessels, and is united to the heads of the old bone. These are accidents which hold us at least in doubt. It is, indeed, an idle mode of proceeding

on such a subject, to suppose that the spinous processes and sutures of the skull are accidentally produced, when design, and the most curious adaptation of parts to their office, are very apparent. To suppose these things produced by chance, is at once to end all enquiry, and to leave a blank in our minds. On this subject I must refer the reader to the dissertation in the following chapter.

It has been supposed, and, with much appearance of truth, that the sutures limit the extent of fractures, leave a free communication of the internal with the external parts; that they must serve as drains from the brain; that they are even capable of opening at times, so as to give relief and ease in the most dreadful diseases of the head: but these uses of them are far from being proved.

The sutures were not intended by nature for limiting the extent of fractures: for fractures traverse the skull in all directions; cross the sutures with ease; and very often, passing all the sutures, they descend quite to the basis of the skull, where we dare not follow them with the knife, nor apply the trepan. Indeed we do not even know that limiting the extent of fractures could be a gracious provision of nature, since it would rather appear by the common accidents, that the more easily the bone yields, the less is the injury to the brain. If a certain violence and shock be committed, and the bone does not yield, and is not fractured, yet the vibration is propagated through it; and concussion is even more dangerous than fracture, because it is a general injury to the brain.

Neither were they intended as drains; for surely it is a bold position to assume, that nature has carefully provided for our making issues upon the sutures. When the original openness of the head and the membraneous condition of the sutures were first observed, it was thought to be an observation of no small importance. The ancients believed that the membranes of the brain came out by the

sutures, to form the pericranium, and going from that over the several joints, formed the periosteum for all the bones. They saw a close connection betwixt the external and internal membranes of the skull, and they thought that nature had intended there a freer communication, and an occasional drain. They found the sutures particularly wide and membraneous in a child, which they attributed to the watery state of its brain, requiring a freer outlet than in the adult; and accordingly they named the opening of the child's head the bregma, fons, fontanelle, the fountain, by which they believed there was a continual exudation of moisture from the brain.

We might have expected these notions to have vanished with the doctrines of humours and revulsion which gave rise to them; but both the doctrines, and the practice, have been revived of late years; and a surgeon of some eminence has been at pains to examine various skulls, trying to find which of all the sutures remains longest open, and which should form the readiest and surest drain; and after a curious examination of each, he decidedly condemns the fontanelle; finds the additamentum of the squamous suture always open, and expects this superior advantage from placing his issues there, that he will command at once a drain both from the cerebellum and from the brain. But these notions of derivation and revulsion, of serous humours falling upon the brain, of drains of pituita by the nose, and through the sutures, though much cherished by the ancients, have been long forgotten, and have not been effectually revived by this attempt.

It cannot be denied, that, in some instances, the sutures have continued quite open in those grown in years, or have opened after a most wonderful manner, in some diseases of the head.

The fontanelle, or opening at the meeting of the coronal and sagittal sutures, was once thought

to be a sure mark for the accoucheur to judge by, both of the life of the child, and of the direction in which its head presents. It is large and soft in a child, and the good women lay a piece of firm cloth upon it, and defend it with particular care. It begins to contract from the time of birth; and in the second and third year it is entirely closed. Its closing is delayed by weakness, scrophulous complaints, and indeed by any lingering disease; it closes very late in rickets, and in hydrocephalic children the bones never close, but continue soft, yield to the watery swelling of the brain, and separate in a wonderful degree, so as to hold ten or twelve pounds. As the sutures continue open in a hydrocephalic child, they are said to open again in the few instances where adults are seized with the same disease.

We cannot pass unnoticed their looseness and flexibility in the new-born child; how wonderfully the head of the child is increased in length, and reduced in breadth in the time of delivery, and how much this conduces to an easy and happy labour.

Were I to assign a reason for the flexible bones, and wide sutures, and the yielding condition of the head of the child, I should say that it were meant by nature to stand in the place of that separation of the bones of the pelvis which has been supposed, but which cannot exist; for the child's head is moulded with little injury, is evolved again without help; and it seems a provision of nature, since the child scarcely feels the change: but no woman has been known to have the joinings of the pelvis relaxed or dissolved without pain and danger, confinement for many months, a temporary lameness, and sometimes being rendered unable to walk for life.

DESCRIPTION OF THE INDIVIDUAL BONES OF THE SKULL.

OS FRONTIS.—This bone is compared with a clam-shell. It is of a semicircular shape, hollowed like a shell. It is divided into the frontal, nasal, and orbitary portions, and it has within it the cavities which are named the sinuses of the frontal bone. The frontal bone is connected by sutures with the parietal bones, &c.

The frontal bone stands connected with the parietal bones by the coronal suture; it is connected to the great ala of the sphenoid bone by the sutura spheno-frontalis; while its orbitary plates are united to the lesser alæ by the linea sphenofrontalis. The nasal bones are attached to it by part of the transverse suture of the face. The cribriform plate of the æthmoid bone is united to the orbitary plates by the linea æthmoidea frontalis, and looking into the orbits the same orbitary plates are seen to be contiguous to the ossa plana of the æthmoid bone and ossa unguis; and, lastly, the ossa malarum are attached to the frontal bone by the extremities of the transverse suture of the face. Its orbitary plates are two thin and diaphanous lamellæ that depart from the part of the bone which forms the forehead in a horizontal direction, so as to form a part of the socket of the eye, and a floor for supporting the anterior lobes of the cerebrum. These two orbitary plates leave an open space, called FISSURA ÆTHMOIDEA, into which part of the æthmoid bone is received.

Its connexions.

Its relations.

Points of demonstration.

1. Orbitary plates.

2. Fissura æthmoidea.

The first point to be remarked is the SUPERCILIARY RIDGE, on which the eye-brows are placed: it is a prominent arched line, corresponding in size and length with the eye-brow, which it supports: over this line the integuments are loose: here many arteries perforate the bone, which are properly the nutritious arteries of this part of the bone; and we find all over the superciliary ridge many small holes through which these arteries had passed. Among these, there is one hole which is

3. Superciliary ridge.

4. Pores, or minute foramina.

5. Superciliary hole. larger, and which is distinguished from the rest; for its use is not like the others, to transmit arteries to the bone, but to give passage to the frontal nerve and a small artery which come out from the orbit, to mount over the forehead. Sometimes the nerve turns freely over the border of the orbit, and makes no mark, or but a slight one; often lying closer upon the bone, it forms a notch; but most commonly, in place of turning fairly over the edge of the orbit, it passes obliquely through the superciliary ridge, and, by perforating the bone, makes a hole. It is accompanied by the superciliary branch of the ophthalmic artery. This hole is named the SUPERCILIARY HOLE.

6. Foramen orbitale. The second foramen is the FORAMEN ORBITALE INTERNUM. It is within the orbit, near the junction of the orbital plate with the æthmoid. It transmits a branch of the ophthalmic division of the fifth nerve from the orbit into the cranium, from which the same nerve immediately passes through the æthmoid into the nose. Sometimes there are two, when they are distinguished by the terms anterior and posterior orbitary foramina; but occasionally there is only a groove, or one side of the foramen, the other being formed by the æthmoid.

7. Angular processes. The orbitary, or superciliary ridge, ends by two processes, which, forming the angles of the eye, are named the ANGULAR PROCESSES. The frontal bone has, therefore, four angular processes: 1. The two internal angular processes, forming the internal angles of the eyes; and 2. The two external angular processes, which form the external angles of each eye.

8. Nasal process. Betwixt the two internal angular processes there is the NASAL POINT OR PROCESS. This nasal process is a small sharp projecting point, occupying that space which is exactly in the middle of the bone, and is betwixt the two internal angular processes. It is very irregular and rough all round its root, for supporting the two small nasal bones; and this gives them a firm seat, and such a hold upon the root of

the forehead, that they oftener are broken than displaced.

From the external angular process there extends backwards and upwards the temporal ridge or spine. 9. Temporal ridge.

At the inner end of the superciliary ridge, is that bump which marks the place of the frontal sinus, which also indicates their size; for where this rising is not found, the sinuses are wanting, or are very small; but this is no sure nor absolute mark of the presence of these sinuses, which often, in the flattest foreheads, are not entirely wanting. Eminentiæ superciliares.

The sinuses* of the os frontis are two in number, one on either side above the root of the nose: they are formed by a receding of the two tables of the skull from each other: they are formed at first with the common cancelli, and at first they resemble the common cancelli, as if they were only larger cells: gradually they enlarge into two distinct cavities, often of very considerable size, going backwards into the orbitary plate, or sideways into the orbitary ridge, or upwards through one half of the frontal bone; and Ruysch had, in a giantess (puella gigantica), seen them pass the coronal suture, and extend some way into the parietal bones. 10. Sinuses.

The two sinuses of either side are divided by a partition; but still they communicate by a small hole: sometimes the partition is almost wanting, and there are only crossings of the common lamellated substance; and though the communication with one another is not always found, they never fail to communicate with the nose: this indeed seems to be their chief use; for the frontal 11. Partitions of the sinuses.

* The word sinus is used in two senses: we call the cavities or cells, within the substance of a bone, the sinuses of that bone; as the sinuses of the forehead, of the sphenoid, æthmoid, or maxillary bones; we call also certain great veins by the same name of sinuses; thus the great veins being enlarged where they approach the heart, and the veins being particularly large in the brain and the womb, we call them the sinuses of the heart, of the brain, and of the womb.

I 2

sinuses are the beginning of a great train of cells, which, commencing thus in the frontal bone, extend through the æthmoidal, sphenoidal, and maxillary bones, so as to form cavities of great extent and use belonging to the nose. These cavities extend and give form to the face, enlarge the cavities which receive effluvia, and allow them to circulate and pass over the proper organ of smelling; and they give perfection and strength to the voice. The membrane which lines these cavities is thin, exquisitely sensible, and is a continuation of the common membrane of the throat and nose. A thin humour is poured out upon its surface to moisten it and keep it right. This the ancients did not consider as a mere lubricating fluid, but as a purgation of the brain, drawn from the pituitary gland, which could not be diminished without danger, and which it was often of consequence to promote.

These cells, or thin membranes, are subject to inflammation and abscess. They are also subject to the accidental nestling of insects, which nestle there, and produce inconceivable distress; and it is particular, that they more frequently lodge in the frontal sinuses, than in the cavities of any of the other bones. In sheep and dogs such insects are very frequent, as in seeking their food, they carry their nose upon the ground; and it has been proved, or almost proved, that in man they arise from a like cause. Indeed, what can we suppose, but that they get there by chance; thus, a man having slept in barns, was afflicted with dreadful disorders in the forehead, which were relieved upon discharging from the nose a worm of that kind which is peculiar to spoiling corn; while others have had the complaint by sleeping upon the grass. The patient might be relieved on easier terms than by the operation of the trepan, which has been proposed, by the injection of aloes, assafœtida, myrrh, the use of snuff or smoking, and pressing the fumes upwards into the nose. Much should be tried, before undertaking a dangerous operation on slender proofs.

It may be right in cases of fractures, to decline applying the trepan above the sinuses, unless a fracture cannot be raised in any easier way; and we must be especially careful to distinguish a fracture of the outer table only from entire fractures of this bone. For Palfin says, that the outer table being broken, and the natural mucus of the sinus being corrupted and flowing out, has been mistaken for the substance of the brain itself. And Parée, who first gives this caution, affirms, "that he had seen "surgeons guilty of this mistake, applying the trepan, "and so killing their unhappy patients."*

The SPINE OR RIDGE which runs upon the internal surface of the frontal bone, is to be observed, as it gives a firm hold to the falx, or that perpendicular membrane, which, running in the middle of the skull, divides and supports the brain. This is more or less prominent in different skulls, and according to the age. The spine is more prominent at its root; but as it advances up the forehead, it decreases, and often ends in a groove. The spine gives firm hold for the falx, and the groove lodges the great longitudinal sinus, or, in other words, the great vein of the brain, which runs along the head, in the course of the perpendicular partition or falx. At the root of this spine, there is a small blind hole; it is named blind, because it does not pass quite through the bone, and the beginning of the falx, dipping down into this hole, gets a firmer hold. The ancients, thinking that the hole descended through both tables into the nose, ignorantly believed, that the dangerous and ungovernable bleedings at the nose must be through this hole, and from the fore-end, or beginning of the longitudinal sinus.

12. Internal spine.

13. Groove.

14. Foramen cæcum.

Upon the orbitary plate, and just under the superciliary ridge, there are two depressions in the socket of each eye: the one is very small, and deeper at the inner corner of the eye, under the superciliary hole,

15. Pit of the trochlea.

* For a more perfect account of the pathology of the sinuses see Mr. John Bell's Principles of Surgery.

which is the mark of the small cartilaginous pully, in which the tendon of one of the muscles of the eye plays; the other, a more gentle and diffused hollow, lies under the external angular process, is not deep, but is wide enough to receive the point of a finger, and is the place where the lachrymal gland lies, that gland which secretes the tears, and keeps the eye moist.*

16. Pit for the lachrymal gland.

On the whole, this bone affords a very important subject of study to the surgeon, and he is especially called to attend to the sinuses, the internal spine, and to the orbitary processes of this bone. These orbitary processes are the most remarkable points of this bone. They are often fractured by a blow on the forehead, and being extremely brittle, the splinters are beat up, and enter the brain. They are no defence to the brain when a weapon enters the orbit. We have known a young man killed by the push of a foil which had lost its guard, and which passed through this plate into the brain.

PARIETAL BONE. — The parietal bones form much the greater share of the cranium: they are more exposed than any others, are the most frequently broken, and the most easily trepanned: for the parietal bones are more uniform in their thickness, and more regular in their two tables and diploe, than any others. But the accidental varieties of pits and depression are very frequent in them, and the sinus or great vein, and the artery which belongs to the membranes of the brain, both make their chief impressions upon this bone. It enters into the formation of the *coronal*, the *sagittal*, the *lambdoidal*, and the *squamous* sutures.

Points of demonstration.

1. The four angles.

The square form of the bone produces four angles; and in surgery, we speak of the frontal, the occipital, the mastoidean, and temporal angles of the parietal bone. It has deeply serrated edges which unite the

* In addition, as points of demonstration, we may add the *eminentiæ frontales*. See the general review of the skeleton.

two bones with each other, and with the occipital and frontal bones. All the corners of this bone are obtuse, except that one which lies in the temple, and which, running out to a greater length than the other corners, is sometimes named the SPINOUS OR TEMPORAL PROCESS of the parietal bone, though there can be no true process in a bone so regular and flat.

2. Spinous process or sphenoidal angle.

The lower edge of the bone is a neat semi-circle, which joins the parietal to the temporal bone; and the edge of each is so slanted off, that the edge of the temporal overlaps the edge of the parietal, with a thin scale forming the squamous suture.

3. Squamous edge.

About an inch above the squamous suture, there is a semi-circular ridge, where the bone is particularly white and hard; and rays extend downwards from this, converging towards the jugum. The white semi-circular line represents the origin of the temporal muscle; and the converging lines express the manner in which the fibres of the muscle are gathered into a smaller compass, to pass under the jugum, or arch of the temple.

4. Temporal ridge.

The sagittal suture, or meeting of the two parietal bones, is marked with a groove as big as the finger, which holds the longitudinal sinus, or great vein of the brain; but the groove is not so distinctly seen, unless the two bones are put together; for one half of this flat groove belongs to each bone.

5. Groove for the sinus.

6. Groove of the meningeal artery.

The great artery of the dura mater touches the bone at that angle of it which lies in the temple. It traverses the bone from corner to corner, spreading from the first point, like the branches of a tree: it beats deep into the bone where it first touches it; but where it expands into branches, its impressions are very slight; commonly it makes a groove only, but sometimes it is entirely buried in the bone; so that at the lower corner of the parietal, we cannot escape cutting this vessel, if we are forced to operate with the trepan.

7. Foramen parietale.

There is but one hole in the parietal bone: it is small and round, is within one inch of the meeting of the lambdoidal and sagittal sutures, and gives passage to a small external vein, which goes in-

wards to the sinus, and to a small artery, which goes also inwards to the dura mater, or rather to the falx.

8. Foveæ. On the inner surface of the bone, and commonly near the sagittal edge, we very often see pits or foveæ, which receive those bodies which are called glands, of the dura mater.

9. Fossa of the sinus. The lateral sinus makes a depression on the inside of the mastoidean angle.

The meeting of the frontal and parietal bones, being imperfect in the child, leaves that membraneous interstice which, by some, is named folium or folliolum, from its resembling a trefoil leaf, and was named by the ancients, hypothetically, bregma, fons*, or fountain; they thinking it a drain for the moisture from the brain: and so the parietal bones are named ossa bregmatis. The parts of these bones which form the upper portion of the skull are equable in their thickness, and there the surgeon would apply his trephine, if he had it in his power to choose; but towards the temporal angle he would apply it unwillingly, because of the meningeal artery, which is apt to be opened, and to be at least troublesome. Formerly, surgeons were forbid to trepan over the longitudinal sinus; now the fashion is altered, and some surgeons would persuade us to prefer it! We do it when necessary, but always with due consideration of the great vein or sinus.

For an account of the veins contained within this bone, see the concluding observations on the bones of the cranium, and under the head of *Emmissariæ*.

OS OCCIPITIS has also the names of os memoriæ and os nervosum. It is the thickest of the cranial bones, but is the least regular in its thickness, being transparent in some places, and in others swelling into ridges of very firm bone. It gives origin or insertion to many of the great muscles

* The word pulsatilis, or fons pulsatilis, or beating fountain, was added, because we feel the beating of the arteries of the brain there.

which move the head and neck; it supports the back part of the brain, contains the cerebellum or lesser brain, transmits the spinal marrow, and is marked with the conflux of the chief sinuses, or great veins of the brain.

This bone is united to the parietal bones by the lambdoidal suture, to the mastoidean portions of the temporal bone by the additamentum suturæ lambdoidalis, laterally and forward it is attached to the petrous portion of the temporal bone, and at its lower and most anterior part, it is attached to the sphenoid bone, by that peculiar bond of union called synostosis.

In beginning the demonstration, we point out its divisions: 1. Pars occipitalis. 2. Pars lateralis or condyloidea. 3. Pars basilaris or cuneiformis; which, at birth, are distinct bones divided by cartilage. It is also necessary to name its angles, viz. the superior or parietal angle, and the mastoidean angles. Points of demonstration.

The EXTERNAL SURFACE is exceedingly irregular, by the impressions of the great muscles of the neck: betwixt the insertions of the muscles, projecting lines are on the bone. In the middle of the bone, and betwixt the muscles of opposite sides, there runs a ridge from above downward; at the upper margin of the insertion of the trapezius, there is formed a superior transverse spine or ridge, and in the same way, directly above the insertion of the recti, which make two irregular depressions, there is an inferior transverse spine. In a strong man, advanced in years, where the ridges and hollows are strongly marked, at the point where the superior transverse crosses the perpendicular one, it is so very prominent, as to be named the POSTERIOR TUBEROSITY of the occipital bone.

1. Perpendicular external spine.

2. Superior transverse spine.

3. Inferior.

4. Tuberosity.

The INTERNAL SURFACE.—Opposite to these ridges there are similar crucial ridges within; but larger, more regular, smooth, and equal, and making only one transverse line, and one perpendicular line. The *tentorium cerebello super-extensum* is a diaphragm or transverse partition, which crosses the skull at its 5. Internal crucial ridges.

back part; cuts off from the rest of the cranium the hollow of the occipital bone, appropriates that cavity for the cerebellum, and defends the cerebellum from the weight and pressure of the brain. This tentorium, or transverse membrane, is attached to the GREAT INTERNAL RIDGE of the occipital bone. In the angle where this membrane is fixed to the ridge, lies the great sinus or vein, which is called the longitudinal sinus, while it is running along the head; but the same sinus, dividing, in the back of the head, into two great branches, changes its name with its direction; and the forkings of the vessel are named the right and left lateral sinuses, which go down through the basis of the skull; and being continued down the neck, are there named the great or internal jugular veins. This forking of the longitudinal into the lateral sinuses, makes a TRIANGULAR OR TRIPODLIKE GROOVE, which follows the internal ridges of the occipital bone: and above and below the transverse ridge there are formed four plain and smooth hollows. The two upper ones are above the tentorium, and contain the posterior lobes of the brain; the two lower ones are under the tentorium, and hold the lobes of the cerebellum or little brain.

6. Grooves for the sinuses.

7. Fossa cerebelli, and fossa cerebri.

8. Cuneiform process.

PROCESSES. — The processes or projections of the occipital bone are few and simple. 1. There is a part of the bone which runs forward from the place of the foramen magnum, lies in the very centre of the base of the skull, joins the occipital to the sphenoidal bone, and which, both on account of its place, (wedged in the basis of the skull,) and of its shape, which is rather small, and somewhat of the form of a wedge, is named the CUNEIFORM, OR WEDGE-LIKE PROCESS of the occipital bone. On the inside of this part of the bone is a slight hollow, to which the name of fossa basilaris is given, and lateral to this the groove of the lower petrous sinus may be observed. And there are two small oval processes, or button-like projections, which stand off from the side, or rather from the fore-part of the foramen magnum, or great hole, and which, being lodged in sockets belonging to

9. Fossa basilaris.

Lateral groove.

10. Condyles.

the upper bone of the neck, form the hinge on which the head moves. These two processes are named the CONDYLES of the occipital bone. They are not very prominent, but rather flattened; are of an oval form, and have their fore-ends turned a little towards each other; so that by this joint the head moves directly backwards or forwards, but cannot turn or roll. The turning motions are performed chiefly by the first bones of the neck. Round the root of each condyle, there is a roughness, which shows where the ligament ties this small joint to the corresponding bone of the neck.

On the lower part of the cuneiform process, there are two tubercles for the attachment of the recti capitis anteriores. Near the condyle, and immediately behind the foramen lacerum, there is a tubercle for the rectus capitis lateralis. 11. Tubercles of the cuneiform process. 12. Small lateral tubercles.

HOLES. — These condyles stand just on the edge of the FORAMEN MAGNUM, or great hole of the skull, which transmits the spinal marrow, or continuation of the brain; and the edges of this hole (which is almost a regular circle) are turned and smoothed; a little thicker at the lip, and having a roughness behind that, giving a firm hold to a ligament, which, departing from this hole, goes down through the whole cavity of the spine, forming in part a sheath for the spinal marrow, and a ligament for each individual bone. There pass down through this great hole the spinal marrow, and the vertebral vein; there come up through it the vertebral arteries, which are of great importance and size; and a nerve, which, from its coming backwards from the spine to assist certain nerves of the brain, is named the spinal accessory nerve. 13. Foramen magnum.

The second hole is placed a little behind the ring of the foramen magnum, and, just at the root of either condyle, is round and large, easily found, and sometimes it is double; it transmits the ninth pair, or great lingual nerve. 14. Foramen condyloideum anterius.

There is another hole smaller, and less regular than this last. It is exactly behind the condyle, while the 15. Posterius.

lingual hole is before it. It is for permitting a small vein of the neck to enter and drop its blood into the great lateral sinus; sometimes it is a hole common to the temporal and occipital bones, but often it is not found, and this trifling vein gets in by the great occipital hole.

16. Part of the foramen lacerum. We shall describe with the temporal bone that wide hole which is common to the temporal and occipital bones, and which transmits the great lateral sinus, and the nerves of the eighth pair.

The surgeon would do well to study, with great care, the place of the posterior tubercle, and to teach himself to calculate the place of the sutures from their protuberance, and as it were from the same land-mark, to estimate the place of the internal spines, and the fossa cerebrales; for these inequalities in the thickness of this bone become of the first consequence in applying the trephine to the back of the head.

TEMPORAL BONE. — The temporal bone is, in the child, two bones; which retain their original names of pars petrosa and pars squamosa. The whole bone is very irregular in its thickness, and hollows and processes. Pars squamosa. The PARS SQUAMOSA is a thin or scaly part; rises like a shell over the lower part of the parietal bone, and is smoothed and flattened as it were by the rubbing of the temporal muscle. Pars petrosa. The PARS PETROSA, often named OS LAPIDOSUM, or stony bone, is hard, irregular, rocky; juts inwards towards the basis of the skull; contains the organ of hearing, and, of course, receives and transmits all the nerves which are connected with the ear.* There is a third portion of this bone, viz. the mastoidean angle, which is Mastoidean angle. thick and hard, is divided into cells, and forms those caverns which are supposed to be chiefly useful in reverberating the sound.

The squamous part is grooved, to make the squamous suture; is scolloped or fringed; and exceedingly

* The anterior and posterior semi-circular canals are protuberant upon its surfaces.

thin on its edge; it is radiated, in consequence of its original ossification shooting out in rays. The petrous part again is triangular, unequal by the cavities of the ear; it has a very hard, shining, polished-like surface; exceeded in hardness by nothing but the enamel of the teeth. Where it projects into the base, it has several open points, which are filled up with cartilaginous or ligamentous substance; and its occipital angle is connected with the other bones by the additamentum suturæ squamosæ.

The temporal bone closes the cranium, upon the lower and lateral part; backwards it is connected by the additamentum suturæ lambdoidalis to the occipital bone; by the squamous suture and the additamentum suturæ squamosæ, it is joined to the parietal bone; whilst anteriorly it is united to the sphenoid bone by the spheno-temporal suture, the spinous process of the sphenoid bone being deeply wedged betwixt the petrous and squamous portions of the temporal bone.

PROCESSES.—The ZYGOMATIC PROCESS rises broad and flat before the ear; grows gradually smaller as it stretches forward to reach the cheek-bone: it forms with it a zygoma, yoke, or arch of the temple, under which the temporal muscle plays. The temporal muscle is strengthened by a firm covering of tendon, which stretches from the upper edge of this zygoma to the white line on the parietal bone; and several muscles of the face arise from the lower edge of the zygoma, particularly one named masseter, which moves the jaw; and one named zygomaticus, or distortor oris, because it draws the angle of the mouth. The zygomatic process is united by a short suture to the cheek-bone.

1. Zygomatic process.

The STYLOID PROCESS is so named from a slight resemblance to the stylus, or point with which the ancients engraved their writings on tables of wax. It is cartilaginous long after birth; even in the adult, it is not completely formed; it is exceedingly delicate and small; and when its cartilaginous point is fairly ossified, as in old men, it is sometimes two inches

2. Styloid process.

long. It stands obliquely out from the basis of the head, and is behind the jaws; so that it gives convenient origin to a ligament which goes downwards to support the os hyoides, or bone of the tongue; and it is the origin of many curious muscles, chiefly of the throat and jaws. One slender muscle going downwards from the styloid process, and expanding over the pharynx, is called stylo-pharyngeus; one going to the os hyoides, is the stylo-hyoideus; one going to the tongue, is the stylo-glossus: and since the process is above and behind these parts, the muscles must all pull backwards and upwards, raising according to their insertions, one the pharynx, another the os hyoides, another the tongue.

3. Vaginal process.

PROCESSUS VAGINALIS will not be easily found, nor acknowledged as a process; for it is only a small rising of a ridge of the bone, with a rough and broken-like edge, on the middle of which the styloid process stands: it is, in short, the root of the styloid process which anatomists have chosen to observe, though it gives origin to no particular part; and which they have named vaginalis, as if it resembled a sheath for the styloid process.

4. Mastoid process.

PROCESSUS MASTOIDEUS, OR MAMMILLARIS, is a conical nipple-like bump, like the point of the thumb; it projects from under the ear, and is easily felt with the finger without; it is hollow, with many cells which enlarge the tympanum, or middle cavity of the ear, and are thought to reverberate and strengthen the sound.

Groove for the digastricus.

Under its root there is a deep and rough rut which gives a firm hold to the first belly of the digastric muscle: and the point or nipple of this process is the point into which the mastoid muscle is inserted from before; and the complexus, obliquus and trachelomastoideus muscles from behind.

5. Auditory process.

The AUDITORY PROCESS is just the outer margin of the hole of the ear. It is in a child a distinct ring, which is laid upon the rest of the bone.* The membrane of the ear is extended upon this ring,

* In brutes it is, indeed, a process standing out.

like the head of a tambour upon its hoop, whence this is named the circle of the tambour by the French, and by us the drum of the ear. In the adult, this ring is fairly united to the bone, and is named the processus auditorius; and may be defined a circle, or ring of bone, with a rough irregular edge; the drum or membrane of the ear is extended upon it, and the cartilaginous tube of the ear is fixed to it; and this ring occupies the space from the root of the mammillary to the root of the zygomatic process.

Betwixt this and the mastoid process there is a kind of fissure, the *rima mastoidea*.

The lower jaw is articulated with this bone by a shallow fossa, which is anterior to the auditory process, and at the root of the zygomatic process. A tubercle immediately before this articulating surface deepens it. A fissure may be observed in nearly the middle of the cavity, which is for the attachment of the ligament which unites the intermediate cartilage of this articulation. This fissure divides the proper articular or glenoid cavity from that fossa which gives lodgment to a deep portion of the parotid gland. 6. Articular fossa. 7. Articular tubercle. 8. Fissure.

Holes. — The temporal bone is perforated with many holes; some for permitting nerves to enter; others to let them out; others for the free passage of air to the internal ear.

The MEATUS AUDITORIUS EXTERNUS (the circle of which has been described) is that deep tube which in the dry bones leads to the interior cavity, the tympanum, but which is closed at the bottom by the membrane of the tympanum in the living body. 9. Meatus auditorius externus.

The MEATUS AUDITORIUS INTERNUS is that hole by which the auditory nerves have access to the ear. It is a very large hole seated upon the back of the pars petrosa. The hole is at first large, smooth, almost a regular circle, with a sort of round lip. Within this are seen many small holes, the meaning of which is this: the nerve of the 7th pair is double from its very origin in the brain: it consists, in fact, of two distinct nerves, the portio dura, 10. Internus.

and the portio mollis. The portio mollis is a large soft and delicate nerve, which constitutes the true organ of hearing; and when it is admitted into the ear, it is expanded into a thin web which spreads into all the cavities of the ear, as the cochlea, semi-circular canals, &c. The portio dura, the smaller part of the nerve, passes indeed through the ear, but it is quite a foreign nerve; it is not distributed within the ear; it keeps the form of a distinct cord, and, passing through the temporal bone, it comes out upon the cheek, where it is expanded; so that the portio dura is a nerve of the face, passing through the ear, but forming no part of that organ. Thus the two nerves, the portio dura and mollis, enter together; they fill the greater hole, and then they part: the portio dura, entering by one distinct hole, takes its course along a distinct canal, the aqueduct of Fallopius, from which it comes out upon the cheek; while the portio mollis, entering by many smaller holes into the cochlea, semi-circular canals, and cavity of the vestibule, is expanded in these cavities to form the proper organ of hearing.

11. Vidian foramen. There is a small hole which will admit the point of a pin upon the fore-part of the petrous bone. This hole receives a small twig reflected from the fifth pair of nerves: the nerve is as small as a sewing thread; it can be traced along the petrous bone by a small groove, which conducts it to the hole; and when it enters the ear it goes into the same canal with the portio dura, and joins itself to it.

12. Stylo-mastoid foramen. The hole by which the portio dura passes out upon the cheek, is found just before the mastoid, and behind the styloid process; and being betwixt the two, it is named the STYLO-MASTOID hole.

13. Eustachian tube. The hole for the Eustachian tube is very irregular. No air can pass through the membrane of the drum; and as air is necessary within the ear, it is conveyed upwards from the palate by the ITER A PALATO AD AUREM, or, as it is commonly called, the EUSTACHIAN TUBE. This tube is long, and of a

trumpet form; its mouth, by which it opens behind the nostril, is wide enough to receive the point of the finger, it grows gradually smaller as it advances towards the ear: it is cartilaginous in almost its whole length; very little of it consists of firm bone; so that the student, in examining the skull, will hardly find the Eustachian tube; for the cartilage being rotted away, nothing is left but that end of the canal that is next the ear, and which opens both above and below, ragged, irregular, and broken.

Above and to the outside of the Eustachian tube there is a narrow canal which conveys the nerve called corda tympani. This nerve, traversing the tympanum, enters into the aqueduct of Fallopius, and unites with the facial nerve. 14. Canal of the corda tympani.

On the inside of the Eustachian tube we may observe a canal which, leading backwards, opens into the cavity of the tympanum with a mouth like a spoon; it gives lodgment to the long muscle of the malleus. 15. Canal of the long muscle of the malleus.

The other holes do not relate to the ear, and are chiefly for transmitting the great blood-vessels of the brain.

The CAROTID ARTERY, the chief artery of the brain, enters into the skull near the point of the petrous bone, and just before the root of the styloid process. The artery goes first directly upwards, then obliquely forwards through the bone, and then again upwards, to emerge upon the inside of the skull; so that the carotid makes the form of an italic *S*, when it is passing through the substance of the bone; and, in place of a mere hole, we find a sort of short canal, wide, a little crooked, and very smooth within. It is at this particular point that we are sensible in our own body of the beating of these two great arteries; and Haller informs us, that, during a fever, he felt this beating in a very distressing degree. The sympathetic nerve accompanying the carotid artery is also transmitted through this canal. 16. Carotid foramen, for the passage of the great artery, and for the sympathetic nerve.

The GREAT LATERAL SINUS comes out in part through the temporal bone, to form the internal 17. Foramen lacerum posterius.

jugular vein. The course of the sinus may be easily traced by the groove of the occipital bone downwards, behind the pars petrosa: there also it makes a deep groove, and ends with a large intestine-like turn, which makes a large cavity in the temporal bone, big enough to receive the point of the finger. The sinus passes out, not by any particular hole in the temporal bone, but by what is called a COMMON HOLE, viz. formed one half by the temporal and one half by the occipital bone. This hole is very large; is lacerated or ragged-like. It is sometimes divided into two openings, by a small point, or spine of bone. The larger opening on one side of that point transmits the great sinus, where it begins to form the jugular vein; and the smaller opening transmits the eighth nerve of the brain.

transmits the internal jugular, and the nerves of the eighth pair.

18. Mastoidean foramen.

There is a small hole on the outside of this bone, in the occipital angle; or rather the hole is oftener found in the line of the suture (the additamentum suturæ squamosæ). Sometimes it is in the occipital bone; or sometimes it is wanting: it transmits a trifling vein from without, into the great sinus, or a small artery going to the dura mater.

19. Ducts of Cotunnius.

There are two very small canals, which carry blood-vessels and lymphatics from the inner cavities of the ear; they have been called aqueductus vestibuli, and aqueductus cochleæ; they open on the posterior surface of the petrous bone, near the internal auditory foramen.

Among the irregular depressions on the different faces of this bone are sometimes enumerated these: the groove already mentioned on the mastoid process for the lodgment of the head of the digastricus; certain cerebral fossæ, which are the impressions of the convolutions of the brain upon the inside of the squamous portion; the jugular fossa, or thimble-like depression, made by the first turn of the great jugular vein; the temporal sinuosity for the lodgment of the temporal muscle; and, lastly, we observe in a well-marked bone, the sulci for the artery of the dura mater, and the groove for the petrous sinus on

the ridge which divides the surfaces of the petrous bone.

The temporal bone is important as a bone of the cranium, and lying in contact with the membranes of the brain. It is subject to scrofulous disease, from containing the complicated organ of hearing. Its diseases not only affect the brain, but in a particular manner influence the muscles of the face, from the nerves transmitted being those of expression.

In concluding the description of the bones of the cranium, I should not omit to state, that all these bones are hollowed out into canals for veins — a late discovery of M. Breschet, of the Hotel Dieu. These veins run in the diploe, and are of a size that makes the surprise the greater they should have been so long neglected. These channels are numerous in the frontal and occipital bone; but they are very conspicuous and regular in the parietal bone. They converge towards the temple considerably behind the course of the meningeal artery. They are to be demonstrated by filing off the external table of the bone. Do these internal and concealed channels determine the course of fractures of the skull? Are these internal veins ever the seat of tumor? *

The ÆTHMOID BONE is perhaps one of the most curious bones of the human body. It appears almost a cube, not of solid bone, but exceedingly light, spongy, and consisting of many convoluted plates which form a net-work like honey-comb. It is curiously enclosed in the os frontis, betwixt the orbitary processes of that bone. One horizontal plate receives the olfactory nerves, which perforate that plate with such a number of small holes, that it resembles a sieve, whence the bone is named cribriform, or æthmoid bone. Other plates, dropping perpendicularly from this one, receive the divided

* See *Recherches Anatomiques sur les Canaux veinaux des Os* Par M. Breschet.

nerves, and give them an opportunity of expanding into the organ of smelling: and these bones, upon which the olfactory nerves are spread out, are so much convoluted, as to extend the surface of this sense very greatly, and are named spongy bones. Another flat plate lies in the orbit of the eye, which being very smooth, for the rolling of the eye, is named the os planum, or smooth bone; so that the æthmoid bone supports the fore part of the brain, receives the olfactory nerves, forms the organ of smelling, and makes a chief part of the orbit of the eye; and the spongy bones, and the os planum, are neither of them distinct bones, but parts of this æthmoid bone. Thus the æthmoid is united to the frontal bone, by the linea æthmoidea frontalis, and to the sphenoid bone by a similar line of contact, visible on the inside of the base of the cranium. Looking into the orbit, we again see a union with the frontal, and with the sphenoidal and palate bones. Its perpendicular plate stands connected to the back part of the nasal process of the frontal bone; the vomer is attached to the back part of this plate. The ossa unguis close the cells of this bone anteriorly. *In the fœtus* the æthmoid bone is divided into two by a cartilaginous partition, which becomes afterwards the perpendicular plate and crista galli.

Connections. Processes.

1. Cribriform plate.

The CRIBRIFORM PLATE is exceedingly delicate and thin, lies horizontally over the root of the nose, and fills up neatly the space betwixt the two orbitary plates of the frontal bone. The olfactory nerves, like two small flat lobes, lie out upon this plate, and, adhering to it, shoot down like many roots through this bone, so as to perforate it with numerous small holes, as if it had been dotted with the point of a pin, or like a nutmeg-grater.

This plate is horizontal; but its processes are perpendicular, one above, and three below.

2. Crista galli.

The first perpendicular process is what is called CRISTA GALLI, a small perpendicular projection somewhat like a cock's comb, but exceedingly small,

standing directly upwards from the middle of the cribriform plate, and dividing that plate into two; so that one olfactory nerve lies upon each side of the crista galli; and the root of the falx, or septum, betwixt the two hemispheres of the brain, begins from this process. The foramen cæcum, or blind hole of the frontal bone, is formed partly by the root of the crista galli, which is very smooth, and sometimes, it is said, hollow or cellular.

3. Nasal plate.

Exactly opposite to this, and in the same direction with it, *i. e.* perpendicularly to the æthmoid plate, stands out the NASAL PLATE of the æthmoid bone. It is sometimes called the azygos, or single process of the æthmoid, and forms the beginning of that septum or partition which divides the two nostrils. This process is thin, but firm, and composed of solid bone; it is commonly inclined a little to one or other side, so as to make the nostrils of unequal size. The azygos process is united with the vomer, which forms the chief part of the partition; so that the septum, or partition of the nose, consists of this azygos process of the æthmoid bone above, of the vomer below, and of the cartilage in the fore or projecting part of the nose; but the cartilage rots away, so that whatever is seen of this septum in the skull must be either of the æthmoid bone or the vomer.

4. The labyrinth.

The lateral parts of the æthmoid bone consist of a series of cells communicating with each other, and which are called the labyrinths. The cells of the labyrinth are closed by the external plate called os planum. These cells belong to the organ of smelling, and are useful by detaining the effluvia of odorous bodies, and by reverberating the voice.

5. Processes called superior spongy bones.

From each of these labyrinths there hangs down a SPONGY BONE, one hanging in each nostril. They are each rolled up like a scroll of parchment; they are very spongy; are covered with a delicate and sensible membrane, and when the olfactory nerves depart from the cribriform plate of the æthmoid bone, they attach themselves to the septum, and to these

upper spongy bones, and expand upon them so, that the convolutions of these bones are of material use in expanding the organ of smelling, and detaining the odorous effluvia till the impression be perfect. Their convolutions are more numerous in the lower animals, in proportion as they need a more acute sense. They are named spongy, or turbinated bones, from their convolutions resembling the many folds of a turban.

5. Os planum. The orbitary plate of the æthmoid bone is a large surface, consisting of a very firm plate of bone, of a regular quadrangular form, exceedingly smooth and polished: it forms a great part of the socket for the eye, lying on its inner side. When we see it in the detached bone, we know it to be just the flat side of the æthmoid bone; but while it is incased in the socket of the eye, we should believe it to be a small square bone; and from this, and from its smoothness, it has got the distinct name of os planum.

The os unguis. The OS UNGUIS should also, perhaps, be counted as a part of the bone; for though when observed in the orbit, it seems to be a small detached bone, thin, like a scale, and of the size of the finger nail (whence it has its name), yet in the adult the os unguis is firmly attached to the æthmoid bone, comes along with it when we separate the pieces of the skull, and when the os unguis is pared off from the æthmoid bone, it exposes the cells. This os unguis is a small scaly-like plate, in the inner corner of the orbit just over the nose, which closes the cells of the æthmoid bone; however, it will be described below as a distinct bone.

The cells of the æthmoid bone, which form so important a share of the organ of smelling, are arranged in great numbers, along the spongy bone. They are small neat cells, much like a honey-comb, and regularly arranged in two rows, parted from each other by a thin partition; so that the os planum seems to have one set of cells attached to it, while another regular set of cells belongs in like manner

to the spongy bones. The cells are thus twelve in number*, opening into each other, and into the nose.

These cells are frequently the seat of venereal ulcers, and the spongy bones are the surface where polypi often sprout up. And from the general connections and forms of the bone, we can easily understand how the venereal ulcer, when deep in the nose, having got to these cells, cannot be cured, but undermines all the face; how the venereal disease, having affected the nose, soon spreads to the eye, and how even the brain itself is not safe. We see the danger of a blow upon the nose, which by a force upon the septum, or middle partition, might depress the delicate cribriform plate, so as to oppress the brain with all the effects of a fractured skull, and where no operation could give relief. And we also see much danger in pulling away polypi, which are firmly attached to the upper spongy bone.

SPHENOIDAL BONE.—The sphenoidal bone completes the cranium, and closes it below. It is named SPHENOID, CUNEIFORM, or WEDGE-LIKE bone, from its being incased in the very basis of the skull; or it is named OS MULTIFORME, from its irregular shape. It is united to fourteen distinct bones. It is much of the shape of a bat, whence it is often named the PTERYGOID BONE: its temporal processes being like extended wings; its proper pterygoid processes like feet; its middle like the body and head of a bat. Its wing-like processes are in the hollow of the temple, forming a part of the squamous suture, and also composing a part of the orbit of the eye: its pterygoid processes hang over the roof of the mouth, forming the back of the nostrils: the body is in the very centre of the skull, and transmits five of the nerves from the brain, besides a reflected nerve; but still the body bears so small a proportion to the bone, that we have not a regular centre to which all the processes can be referred; so that we

* The number is commonly twelve, but not regularly so.

are always, in describing this bone, moving forwards from point to point, from one process or hole to the next.

Points of demonstration.

1. Great alæ.

PROCESSES. — The ALÆ, or WINGS, often named temporal processes, rise up in the temple, to form a part of the hollow of the temple; and the wings of the sphenoid bone meeting the frontal, parietal, and temporal bones, by a thin scaly edge, they make part of the squamous suture, and give a smooth surface for the temporal muscle to play upon.

Its surfaces.

2. Orbital plate.

The other side of this same process looks towards the socket of the eye, and has a very regular and smooth surface; it is opposite to the os planum. As the æthmoid bone forms part of the inside of the orbit, the wing of the sphenoid bone forms part of the outside of the orbit; and so the surface turned towards the eye is named the ORBITARY PROCESS of the sphenoid bone, or ORBITARY PLATE of the great alæ.

3. Cerebral.

The surface of the great wing which looks backward receives the middle lobe of the cerebrum, and is called the CEREBRAL FOSSA; and that which is external and receiving the temporal muscle, is called the TEMPORAL FOSSA.

4. and Temporal fossæ.

5. Spinous process.

The lower, or back part of this bone runs out into a narrow point, which sinks in under the petrous portion of the temporal bone, and being sharp pointed, it is named the SPINOUS PROCESS. It is very remarkable for a small hole which permits the great artery of the dura mater to enter.

6. Styloid process.

The point of this spinous process projects in the *form of a very small peak, which will hardly be found by the student. It projects from the basis of the skull,* just within the condyle of the lower jaw, and being a small point, like the point of the stylus, or iron pen, it also is named STYLOID PROCESS.

7. Wing of Ingrasias.

The LESSER WING OF INGRASIAS next attracts the eye. It is that part of the bone which unites (by harmonia) with the orbitary plate of the frontal bone, and with the æthmoid bone.

8. Transverse spinous process.

This lesser wing projects laterally into the TRANSVERSE SPINOUS PROCESS.

The PTERYGOID PROCESSES * are four in number, two on each side. They are those processes upon which (with the spinous process) the bone naturally stands, and which, when we compare it with a bat, represent the legs; one of each side, is named external pterygoid, the other is named the internal pterygoid process. Pterygoid processes.

Each EXTERNAL PTERYGOID PROCESS is thin and broad, and extends farther backwards. Each INTERNAL PTERYGOID PROCESS is taller and more slender, and not so broad. It has its end rising higher than the other, and tipped with a small neat hook, named the hook of the pterygoid process (viz. the HAMULAR PROCESS). The inner pterygoid processes form the back of the nostrils. The hook of the pterygoid process is called the hook of the palate, of which it forms the backmost point. The musculus circumflexus vel tensor palati, rising from the mouth of the Eustachian tube, turns with a small tendon round this hook, like a rope over its pulley; and the great muscles of the lower jaw, the only ones for moving it sideways, or for its grinding motions, arise from the pterygoid processes. Betwixt the two processes there is a hollow which is called the fossa pterygoidea, and at the root of the internal pterygoid process there is a groove which leads to the mouth of the Eustachian tube. 9. External. 10. Internal. 11. Hamular process. 12. Fossa pterygoidea.

The AZYGOS PROCESS† is so named, from its being single, because it is seated in the centre of the bone, so that it can have no fellow. It stands perpendicularly downwards and forwards, over the centre of the nose, and its chief use is to give a firm 13. Azygos process.

* There is some confusion in this name, since pterygoid signifies aliform or wing-like processes.

† Azygos is a term which is applied to such parts as have no fellow; because almost always the parts on one side of the body are balanced by similar and corresponding parts on the other side. When they stand in the centre of the body, or are otherwise single, we call them azygos, and so the azygos process of the æthmoid and sphenoid, and other bones; or the azygos vein, which runs in the centre of the thorax, and is single.

seat or insertion for the vomer or bone, which forms the septum. The vomer, or proper bone of the partition, stands with a split edge, astride over this process, so as to have a very firm seat. A kind of union which has been called *gomphosis*.

14. Anterior clynoid processes. The CLYNOID PROCESSES have, like many parts of the human body, a very whimsical name, very ill-suited to express their form; for it is not easy, in this instance, to acknowledge the likeness of four little knobs to bed-posts; yet the clynoid processes are very remarkable. The TWO ANTERIOR CLYNOID PROCESSES are small bumps, rather sharp, projecting backwards, and terminating in two flat projecting

15. Posterior. points. The POSTERIOR CLYNOID PROCESSES rise about an inch farther backwards, and are, as it were, opposed to the others. They rise in one broad and flat process, which divides above into two points, small and round, or knobby at their points; and they look forwards towards the anterior clynoid processes.

16. Tuberculum. The TUBERCULUM OLIVARE is an eminence betwixt the anterior clynoid process and before the *sella turcica*.

17. Sella turcica. The SELLA TURCICA, EPHIPPIUM, or Turkish saddle, is the space enclosed by these four processes, and is well named. The sella turcica, supports the pituitary gland, an appendage of the brain, the use of which is unknown. The carotid arteries rise up by the sides of the sella turcica, and mark its sides with a broad groove. The optic nerves lie upon a groove at the fore-part of the sella turcica, betwixt the two anterior clynoid processes; and sometimes the two anterior processes stretch backwards, till they meet the posterior ones, and form an arch, under which the carotid artery lies. Often the posterior clynoid knobs cannot be fairly distinguished; since, in many skulls, they form but one broad process.

18. Depression for the carotid. On the side of the posterior clynoid process, the carotid artery as it rises impresses its form upon the bone.

The cone, or triangular process, is singularly placed in obscurity, when the bones are in union, and in separating the sphenoid bone it is very apt to be broken off. This process closes the cell, and projects laterally towards the deepest part of the orbit, but so as to be concealed by the palate bone. 19. Triangular process.

This bone has also its cells, for all that part which we call the body of the bone, all the sella turcica, that space which is betwixt the clynoid processes within and the azygos process without, is hollowed into one large cell, divided with a middle partition. It is, indeed, less regular than the other cells; it is sometimes very large, sometimes it is not to be found; it has other trifling varieties which it were idle to describe. As it communicates with the æthmoid cells, it probably performs one office with them, is almost a continuation of them, so that when any one is less or wanting, the others are proportionably larger. 20. Sphenoid cell.

In the fœtus there is no sphenoid cell; and the great alæ can be separated by maceration.

HOLES. — The sphenoid bone is so placed in the very centre of the skull, that its holes transmit the principal nerves of the skull, and it bears the marks of the chief arteries.

The OPTIC HOLES are large round holes, just under each anterior clynoid process. We trace the optic nerves by a large groove into each optic hole; and an artery goes along with them, named the ophthalmic artery, nearly the size of a crow-quill, twisting round the optic nerve, and giving arteries to the eye-lids, muscles, and lachrymal gland, but most especially to the ball and humours of the eye itself. This ocular or ophthalmic artery comes off from the great carotid, while it lies by the side of the sella turcica: and it is a branch again of this ophthalmic artery, which goes out upon the forehead, through the superciliary notch, or hole. 21. Optic foramen.

The FORAMEN LACERUM ANTERIUS is next in order, and is so named because it is a wide slit. It is also 22. Foramen lacerum.

called superior orbitary fissure. The foramen lacerum is wide near the sella turcica, grows gradually narrower, as it goes out towards the temple, till it terminates almost in a slit. The upper line of the foramen lacerum is formed by the transverse spinous process, extending outwards, sharp and flat.

The nerves of the skull are counted from before backwards. There are nine nerves, proper to the skull; the first, or olfactory nerve, perforates the cribriform bone; the second, or optic nerve, passes through the optic hole; the third, fourth, part of the fifth, and sixth pairs of the nerves, pass through this foramen lacerum, or wide hole, to go also into the orbit. The optic nerve forms the proper organ of vision. The smaller nerves of the third, fourth, fifth, and sixth pairs, go to animate its muscles or bestow sensibility, and, passing through the orbit, to mount upon the forehead, or go downwards into the nose.

23. Foramen rotundum. The FORAMEN ROTUNDUM is named from its round shape. The foramen opticum is indeed round, but it has already got an appropriated name. Now to give the young anatomist a regular notion of this, and of the next hole, we must enumerate the branches of the fifth pair. The fifth nerve of the brain is as broad as the little finger, and lies by the side of the sella turcica, where it divides into three lesser nerves, which are called branches of the fifth pair. The first branch of the fifth pair is destined for the eye; the second branch of the fifth pair for the upper jaw; the third branch of this fifth pair for the lower jaw: so the first branch of the fifth pair passes through the foramen lacerum to the eye; the second branch of the fifth pair passes through the foramen rotundum to the upper jaw; the third branch of this great nerve passes through the foramen ovale to the lower jaw.

The foramen rotundum, then, is a hole exactly round, pretty large, opening immediately under the inner end of the foramen lacerum, and transmitting the second branch of the fifth pair of nerves to the upper jaw.

24. Foramen ovale.

The FORAMEN OVALE is an oval hole, larger than the foramen rotundum; about half an inch behind it: and transmitting the third branch of the fifth pair to the lower jaw.

25. Foramen spinale.

The FORAMEN SPINALE, OR SPINOUS HOLE, is a very small round hole, as if made with a large pin; is in the very point of the spinous process; is one third of an inch behind the oval hole, and transmits the small artery, less than a crow-quill, which constitutes the chief artery of the dura mater, viz. that artery which makes its impression upon the parietal bone.

26. Foramen pterygoideum.

There is still another hole, which transmits a nerve curious in this respect, that it is not going out from the skull, but returning into it: for the second branch of the fifth pair, or the superior maxillary nerve, sends a small branch backwards, which, having come within the skull, enters the temporal bone, and goes to join itself to the portio dura of the seventh pair, and in its way gives a small branch, to help out the slender beginning of the great sympathetic nerve. This retrograde branch of the superior maxillary nerve gets back again into the skull, by a hole which is found just under the root of each pterygoid process, whence it is named PTERYGOID HOLE: or, by many, is named after its discoverer, the VIDIAN HOLE.* This hole is almost hidden under the point of the petrous bone; is not to be seen unless in the separated bones, and is nearly of the size of the spinous hole.

27. Irregular foramina.

If there are found some minute holes about the sella turcica, they are the marks of some blood-vessels entering the bone to nourish it.

Common foramina.

28. Foramen lacerum medium.

When the bones of the cranium are united, there is apparent an irregular hole, which corresponds well with the name foramen lacerum medium. It is the continuation of the carotid foramen, but belongs equally to the sphenoid, temporal, and occipital

* This retrograde twig is the little nerve which perforates the os petrosum on its fore part. Vidus Vidius was a professor of Paris, and physician to Francis the First.

bones. The petrous portion of the temporal bone points to it.*

29. Spheno-maxillary fissure. There is a second common hole formed betwixt the sphenoid, the maxillary, and cheek-bone. It is called the spheno-maxillary fissure.

There is a third common hole betwixt the cell of the palate-bone (in the separate bone a groove may be noticed on the back part of this cell) and the root of the pterygoid process. This hole transmits an artery, and a twig of the fifth pair of nerves, into the membrane of the nose.

30. Spheno-palatine fissure.

OF THE BONES OF THE FACE AND JAWS.

The face is composed of a great number of small bones, which are grouped together under the common name of upper and lower jaw. There are bones on either side of the face, and a central or azygos bone: but as their names could convey no distinct notion of the uses, forms, or places of these bones, to enumerate them were but waste of time: they have indeed sutures, and their sutures have been very regularly enumerated; but these bones meet each other by such thin edges, that no indentation nor proper suture is formed. None of these sutures run for any length, or are of any note, therefore I have only this to say, concerning the sutures of the face, that they are acknowledged to be purely a consequence of the ossification having begun in many points: no particular design of nature has been supposed. The sutures, if they require names, are to be named after the bones which they unite together.

* It is called medium because there is a foramen lacerum betwixt the temporal and occipital bones which make three of that name.

OSSA NASI.—The ossa nasi are small bones, rather thin, having no cancelli, being merely firm and condensed plates. They are convex outwardly, so that the two together form nearly an arch. They are opposed to each other by a pretty broad surface, so that their thin arch is firm. They have a flat rough surface, by which they are laid upon the rough surface of the frontal bone; so that there also their connection is strong. They are enclosed by a branch of the upper jaw-bone, which, stretching upwards, is named its nasal process: and they lie with their edges under it in one part, and above it in another, in such a way that they cannot easily be forced in. Lastly, their lower edge is rough, for the firm attachment of the cartilages of the nose; and their lowest point, or that where the bones of the nose and the gristles of the nose are joined, is the most prominent point (or, as it is vulgarly called, the bridge) of the nose; from which connection, notwithstanding its firmness, the cartilages are sometimes luxated.

The only point like a process in these bones is, that rough ridge formed by their union which projects towards the cavity, to give attachment to the nasal plate of the æthmoid bone.

Os UNGUIS, so named from its being of the size and shape of the nail of the finger; or sometimes named the OS LACHRYMALE, from its holding the duct which conveys the tears, is that thin scale of bone which I have described as belonging to the os æthmoides. It is commonly described as a distinct bone; it is a thin flat bone, a single scale, without 1. Ridge.
any cancelli, having only one sharp ridge upon it; it forms a groove for lodging the lachrymal sac, and is 2. Groove.
of course found in the inner angle of the eye at its fore part, and just touching the top of the nose. One half of this bone is behind the groove, and there the eye rolls upon it. One half of it is occupied by the groove for the nasal duct; and the other side of the groove is formed by the rising branch or nasal process, as it is called, of the upper jaw-bone. The os unguis is delicate, and easily broken, being as thin as

a sheet of paper. It is this bone which is pierced in the operation for the fistula lachrymalis, which is easily done, almost with a blunt steel or probe; and the chief caution is to perforate in the place of the groove, as that will lead into the nose, and not behind it, which would carry the perforating instrument into the æthmoidal sinuses, and perhaps wound the spongy bone; nor more forward, as that would be ineffectual from the strength of the nasal process of the maxillary bone.

This bone seems peculiarly liable to caries, which is perhaps the nature of all these thin bones; for as they have no marrow, they must depend entirely on their periosteum for their blood-vessels, which they are no sooner robbed of than they die.

Ossa maxillaria superiora.—The upper jaw-bones are particularly worthy of notice; for here we find all that is curious in the face, even to its size and shape. The upper jaw-bones are of a very great size, forming, as it were, the foundation or basis of the face. They send a large branch upwards, which forms the sides of the nose; a broad plate goes backwards, which forms the roof of the palate. There is a circular projection below, which forms the alveoli, or sockets of the teeth. The upper jaw-bones are quite hollow within, forming a very large cavity, which is capable of containing an ounce of fluid, or more; and the size of this cavity seems to determine the height of the cheek-bone and the form of the face; and the diseased enlargement of this cavity raises the cheek-bone, protrudes the eye, and deforms the face in a very extraordinary degree.

These processes, and this cavity of the bone, are what deserve most particular notice.

Surfaces. The surfaces or plates of the bone are these: external or *malar*; the superior or *orbital*; the internal or *nasal*; the inferior or *palatine*.

Connections. From this description we shall understand the connections of the bone. It is attached forward and upward to the nasal and frontal bones; laterally to the cheek-bone, and in the orbit it is connected with

the lachrymal and æthmoid bones; towards the nasal cavities it has the vomer, palate-bone and lower spongy bones attached to it; and at the back part it touches the sphenoid bone.

The first process is the NASAL PROCESS, which extends upwards to form the side of the nose. It is arched outwards, to give the nostrils shape. Its sides support the nasal bones; and the cartilages of the alæ nasi, or wings of the nose, are fixed to the edges of this process. On the inside and root of the nasal process there is a rough horizontal ridge, which gives attachment to the fore part of the inferior spongy bone.

1. Nasal process.

2. Internal ridge.

A plate of this bone is called the orbitary process. This thin plate is the roof of the great cavity, which occupies this bone entirely. It is at once as a roof to the antrum maxillare, and as a floor for the eye to roll upon. There is a wide groove along the upper surface of this plate, in which the chief branch of the upper maxillary nerve lies: and this nerve, named infra-orbitary nerve, from its lying thus under the eye, comes out by a hole of the jaw-bone under the eye, which is named infra-orbitary hole. And thus the nerve appearing upon the cheek, becomes a nerve of the face.

3. Orbitary plate.

Infra-orbitary canal.

This great bone is the basis upon which the cheek-bone stands; and that it may have a firm place, there is a rough and (as anatomists call it) scabrous surface, of a triangular shape, which makes a very firm suture with the cheek-bone; and as this surface rises a little, it is named the MALAR PROCESS.

4. Malar process.

From the lower circle of the upper bone there projects a semicircle of bone, which is for lodging the teeth of the upper jaw. This circle of bone is as deep as the fangs of the teeth are long. And it may be very truly named a process (PROCESSUS ALVEOLARIS), since it does not exist in the fœtus, nor till the teeth begin to be formed; since it grows along with the teeth, and is absorbed and carried clean away when in old age the teeth fall out. The sides of the sockets in which the teeth are lodged are

5. Alveolar process.

extremely thin, and surround them closely. The teeth are so closely embraced by their sockets, and we are so far from being possessed of any instrument by which they can be pulled perpendicularly out, that the sockets can seldom escape; they are broken or splintered in perhaps one of four extractions, even by the most dexterous artists in that line.

6. Palate process. The PALATE PROCESS is a plate of bone which divides the nose from the mouth, constituting the roof of the palate, and the floor or bottom of the nostrils. This plate is thinner in its middle, and thicker at either edge: thus, it is thick where it first comes off from the alveolar process; it is thin in its middle; and it is again thick where it meets its fellow of the opposite side. For at the place where the two upper jaw-bones meet, the palate-plate is turned upwards, so that the two bones are opposed to each other in the middle of the palate by a broad flat surface, which cannot be seen but by separating the bones. Its suture. This surface is so very rough, that the middle palate-suture almost resembles the sutures of the skull; and the maxillary bones are neither easily separated, nor easily joined again. 7. Nasal spine. This meeting of the palate-plates by a broad surface makes a rising spine, or sharp ridge, towards the nostrils, so that the broadness of the surface by which these bones meet serves a double purpose; it joins the bones securely, and it forms a small ridge upon which the split edge of the vomer, or partition of the nose, is planted. Thus we find the palate-plate of the maxillary bones conjoined, forming almost the whole of the palate, while what are properly called the palate-bones form a very small share of the back part of the roof of the mouth. As these thinner bones of the face have no marrow, they are nourished by their periosteum only; they are of course perforated with many small holes. A great many minute holes are found along the palate-plate, about the place of the sockets, and indeed all over the maxillary bones; and this is particular in the palate, that the hard membrane, or covering of it, is fixed to the bony plate by many

rough tubercles, and even by small hooks, which are easily found in the dried bone.

6. Internal nasal plate.

Since we are describing the plates of the bone as processes, we ought to enumerate the *facies interna nasalis* as an INTERNAL NASAL PLATE. This is the side of the bone which is towards the cavity of the nose, on which the lower spongy bone hangs, and which is perforated to allow a communication betwixt the great cell and the nose.

7. Antrum maxillare.

The ANTRUM MAXILLARE, or cavity of the jaw-bone, is commonly named ANTRUM HIGHMORIANUM, after its discoverer, Highmore. We have gone round the antrum on all its sides, in describing these processes of the bone: the palate-plate makes the floor of the antrum; the orbitary process makes its roof; the cheek, quite up from the sockets of the teeth to the lower part of the eye, forms its walls or sides: so that when the antrum enlarges, it is the cheek that becomes deformed; and when we design to open the antrum, we either perforate its anterior surface within the cheek, or pull one of the teeth. The antrum is round towards the cheek, but it has a flat side towards the nose; it is divided from the cavity of the nostril by a flat and very thin plate of bone; it seems in the naked skull to have a very wide opening; but in the skull, covered with its soft parts, we find the antrum almost closed by a membrane which stretches over the opening, and leaves but one or two very small holes, of the size of the smallest pea, by which, perhaps, the reverberation of sound in the antrum is more effectual in raising the voice, and by which small hole the mucus, which is secreted in the antrum, drops out into the nose.

Its membrana.

The cavity of the antrum, like the inner surfaces of the nostrils, is covered with a membrane, and is bedewed with mucus; and the mucus drops more or less freely in various positions of the head. Sometimes by cold or other accidents, inflammations and swellings of the membrane come on; the holes are closed; the drain of matter is suppressed and confined within, and the cheek swells. Perhaps there may be some particular

disease of the membrane with which the cavity is lined, or of the bone itself: in one way or other, diseases of this cavity, and collections of matter, dreadful pain and caries of the bone, are very frequent: then the cheek rises: the face is irrecoverably deformed. Sometimes the matter makes its way by the sides of the teeth, or at last it bursts through the bones, makes an ulcer in the cheek; and then there is a natural cure, but slow and uncertain. There is no very sure mark of this disease; it may be known by an attentive retrospect of all the circumstances. The disease is not to be easily nor certainly discovered; but a very long continued tooth-ache, an uncommon degree of pain or greater affection of the eye, with a swelling and redness and gradual rising of the cheek, are very suspicious signs. The pulling of the second or third of the grinding teeth, often brings a splinter away with it, which opens a road for the matter to flow; or though there be no breach of the socket, often the confined matter follows the tooth, because not unfrequently the longer fangs of the grinders naturally penetrate quite into this cavity of the jaw: if the matter should not flow, the floor of the antrum is easily perforated, by introducing a sharp stilet by the socket of the tooth that is pulled. The flow of the matter gives relief, and injections complete the cure. But as this opening is sometimes a cure, it is sometimes also a disease; for the breaking of a socket, sometimes opening a way into this antrum, there follows inflammation of its internal surface, a running of matter, and sometimes caries of the bone.

Root of the second molaris projects into it.

Foramina.

HOLES. — There is only one perfect hole in this bone; but, by its union with other bones, it forms four more: the INFRA-ORBITARY hole, for transmitting the infra-orbitary nerve from the bottom of the eye, is the opening of the canal which comes along under the eye. It is just under the margin of the orbit, or sometimes the nerve which it transmits, divides, and makes two smaller holes in its passage upon the cheek. A hole in the palate-plate, which belongs

10. Infra-orbitary hole.

equally to each of the maxillary bones, may be counted the second foramen; for it is betwixt the two bones in the fore part or beginning of the palate-suture behind the two first cutting teeth. This hole is named FORAMEN INCISIVUM, as opening just behind the incisive or cutting teeth; or it is named ANTERIOR PALATINE HOLE, to distinguish it from one in the back of the palate. This hole is large enough to receive the point of a quill; it is single towards the mouth; but towards the nose it has two large openings, one opening distinctly into each nostril. 11. Foramen incisivum.

But it will be well to explain here a third hole, which is common to the maxillary with the proper palate-bone. It is formed on the back part of the palate (one on either side), in the suture which joins the palate-bones to the jaw-bones: it is named POSTERIOR PALATINE HOLE: it is as large as the anterior palatine hole, but it serves a much more important purpose; for the upper maxillary nerve sends a large branch to the palate, which branch comes down behind the back of the nostril, perforates the back of the palate by the posterior palatine hole, and then goes forward in two great branches along the palate. Thus the chief nerves of the palate come down to it through these posterior palatine holes. The use of the anterior palatine hole has long been a problem. It looks almost as if it were merely designed for giving the soft palate a surer hold upon the bone; but Hunter and Scarpa describe a nerve from the fifth pair, taking its course in this way to the soft palate. 12. Posterior palatine hole.

The fourth foramen is formed by the union of the lower spongy bone to the internal nasal plate of the bone; and is for the transmission of the lachrymal duct: the groove will be observed just behind the upright nasal process. 13. Lachrymal groove.

The LATERAL ORBITARY FISSURE, called oftener SPHENO-MAXILLARY FISSURE, has been already noticed: it is a slit formed by this bone and the sphenoid bone; 14. Lateral orbitary fissure.

it is a communication betwixt the orbit and temple; the deepest part is named spheno-palatine fissure.

The whole surface of the bone which forms the antrum is perforated with frequent small holes, especially towards its back part, transmitting small arteries and nerves to the teeth; and the back part of the antrum forms with the orbitary part of the sphenoid bone a second foramen lacerum for the orbit, which is an irregular opening towards the bottom of the socket, and is for the accumulation of fat, rather than for the transmission of nerves; and it is from the wasting of this fat, taken back into the system, that the eye sinks so remarkably in fevers, consumptions, and such other diseases as waste the
15. Alveolar foramina. body. At the termination of the alveolar circle, backwards, there are two or three holes, into which the branches of the internal maxillary artery enter, which go to supply the teeth of the upper jaw. There is a trifling hole for the transmission of an artery on the nasal plate of this bone.

The OSSA PALATI, or PALATE-BONES, are very small, but have such a number of parts, and such curious connections, as are not easily explained. They seem to eke out the superior maxillary bones, so as to lengthen the palate, and complete the nostrils behind: they even extend upwards into the socket, so as to form a part of its circle; although, in looking for them upon the entire skull, all these parts are so hidden, that we should suppose the palate-bones to be of no greater use nor extent than to lengthen the palate a little backwards.

The parts of the palate-bone are these:

1. Palatine plate. The PALATINE PLATE, or process of the palate-bone, whence it has its name, lies horizontal in the same level with the palatine process of the jaw-bone, which it resembles in its rough and spinous surface, in its thinness, in its being thinner in the middle, and thicker at each end; in its being opposed to its fellow by a broad surface, which completes the

MIDDLE PALATINE SUTURE; and it is connected with the palate process of the jaw by a suture resembling that by which the opposite bones are joined; but this suture, going across the back part of the palate, is named the TRANSVERSE PALATINE SUTURE. Where the two palate-bones are joined, they run backwards, into an acute point; on either side of that middle point, they make a semi-circular line, and again run out into two points behind the grinding teeth of each side. By this figure of the bones, the back line of the palate has a scolloped or waved form. The velum palati, or curtain of the palate, is a little arched, following the general line of the bones; the uvula, or pap, hangs exactly from the middle of the velum, taking its origin from the middle projecting point of the two bones; and a small muscle, the azygos uvulæ, runs down in the middle of the velum, taking its origin from this middle part of the bones.

The small projecting point of the palate-bone, just behind the last grinding tooth, touches the pterygoid process of the sphenoid bone; it is, therefore, named the PTERYGOID PROCESS of the palate-bone; but it is so joined with the pterygoid process of the sphenoidal bone, that they are not to be distinguished in the entire skull. The posterior pterygoid hole, or third hole of the palate, is just before this point. 2. Pterygoid process.

The NASAL PLATE, OR PROCESS, is a thin and single plate; rises perpendicularly upwards from the palate; lies upon the side and back part of the nostrils, so as to form their opening backwards into the throat; it is so joined to the upper jaw-bone, that it lies there like a sounding-board upon the side of the antrum Highmorianum, and completes that cavity forming the thin partition betwixt it and the nose. On the inside of the nasal plate there is a rough projection which runs horizontally, and is the continuation of a spine of the maxillary bone, for the attachment of the lower spongy bone. On the outside of the nasal process is the groove for the palatine nerve. 3. Nasal plate. 4. Ridge. 5. Groove

6. Orbitary plate and cell. This nasal process extends thus up from the back arch of the palate to the back part of the orbit; and, though the nasal plate is very thin and delicate in its whole length, yet, where it enters into the orbit, it is enlarged into an irregular kind of knob of a triangular form. This knob is named its ORBITARY PROCESS; or, as the knob has two faces looking two ways in the orbit, it is divided sometimes (as by Monro the father) into two orbitary processes, the anterior and posterior; the anterior one is the chief. This orbitary process, or point of the palate-bone, being triangular, very small, and very deep in the socket, is not easily discovered in the entire skull.

7. Its cell. This orbitary process is most commonly hollow or cellular, and its cells are so joined to those of the sphenoid bone, that it is the palate-bone that shuts the sphenoid cells, and the sphenoid and PALATINE CELLS of each side constitute but one general cavity.

The OSSA SPONGIOSA, or TURBINATA INFERIORA, are so named, to distinguish them from the upper spongy bones, which belong to the os æthmoides; but these lower spongy bones are quite distinct, formed apart, and connected in a very slight way with the upper jaw-bones.

The OSSA SPONGIOSA INFERIORA are two bones, much rolled or convoluted, very spongy, much resembling puff-paste, having exactly such holes, cavities, and net-work, as we see in raised paste, so that they are exceedingly light. They lie rolled up, in the lower part of the nose; are particularly large in sheep; are easily seen either in the entire subject or in the naked skull. Their point forms that projection which we touch with the finger in picking the nose; and from that indecent practice, very often serious consequences arise; for in many instances, polypi of the lower spongy bones, which can be fairly traced to hurts of this kind, grow so as to extend down the throat, causing suffocation and death.

One membrane constitutes the universal lining of the cavities of the nose, and the coverings of all the spongy bones. This continuity of the membrane prevents our seeing in the subject how slightly the spongy bones are hung; but in the bare and dissected skull we find a neat small HOOK upon the spongy bone, by which it is hung upon the edge of the antrum maxillare; for this lower spongy bone is laid upon the side of the antrum, so as to help the palate-bone in closing or covering that cavity from within. One END of the spongy bone, rather more acute, is turned towards the opening of the nostril, and covers the end of the lachrymal duct: the other END of the same bone points backwards towards the throat. The curling plate hangs down into the cavity of the nostril, with its arched side towards the nose. This spongy bone differs from the spongy process of the æthmoid bone, in being less turbinated or complex, in having no cells connected with it, and perhaps it is less directly related to the organ of smell. If polypi arise from the upper spongy bone, we can use less freedom, and dare hardly pull them away, for fear of injuring the cribriform plate of the æthmoid bone. We are indeed not absolutely prohibited from pulling the polypi from the upper spongy bone; but we are more at ease in pulling them from the lower one, since it is quite an insulated bone. When peas, or any such foreign bodies, are detained in the nose, it must be from swelling, and being detained among the spongy bones.

The spongy bones are not absolutely limited in their number: there is sometimes found betwixt these two a third set of small turbinated bones, commonly belonging to the æthmoid bone.

VOMER. — The nose is completed by the vomer, which is named from its resemblance to a ploughshare, and which divides the two nostrils from each other: it is a thin and slender bone, consisting evidently of two plates, much compressed together, Plate very dense and strong, but still so thin as to be

transparent. The two plates of which the vomer is composed split or part from each other at every edge of it, so as to form a groove on every side.

United with the æthmoid. 1. On its upper part, or, as we may call it, its base, by which it is fixed to the skull, the vomer has a WIDE GROOVE, receiving the perpendicular plate of

The sphenoid. the æthmoid and sphenoid bones: thus it stands very firm and secure, and capable of resisting very violent blows. 2. Upon its lower part its groove is narrower, and receives the rising line in the middle of the

The palate-bone. palate-plate, where the bones meet to form the palate-suture. At its fore part it is united by a ragged surface, and by something like a groove, to the middle cartilage of the nose; and, as the vomer receives the other bones into its grooves, it is in a manner locked in on all sides: it receives support and strength from each; and if the vomer and its cartilage should seem too slender a support for the fabric of the nose, let it be remembered, that they are all firmly connected, and covered by one continuous membrane, which is thick and strong, and that this is as a periosteum, or rather like a continued ligament, which increases greatly the thickness and the strength of every one of these thin plates. The vomer, in almost every subject, bends much towards one or other nostril, so as sometimes to occasion no small apprehension, when it happens to be first observed.

OS MALÆ, or the bone of the cheek, is easily known. It is that large square bone which forms the cheek: it has four distinct points, which anatomists have chosen to demonstrate with a very superfluous

1. Upper orbitary process. accuracy. The UPPER ORBITARY PROCESS stands highest, running upwards to form part of the socket, the outer corner of the eye, and the sharp edge of

2. Inferior orbitary process. the temple. The INFERIOR ORBITARY PROCESS, which is just opposite to this, forming the lower part of the

3. Maxillary process. orbit, and the edge of the cheek. The MAXILLARY PROCESS is that broad and rough surface, by which it is joined to the upper jaw-bone. The one the best entitled to the name of process, because it stands

out quite insulated, and goes outwards and backwards to unite with the temporal bone, forming the zygoma or temporal arch, is named the ZYGOMATIC PROCESS. That plate, which goes backwards to form a part of the orbit, is named the INTERNAL ORBITARY PROCESS. A small hole is observed on the outer surface of the bone, which transmits an artery, and sometimes a very small nerve, from the orbit.

4. Zygomatic process.

5. Internal orbitary process.

6. Foramen.

OS MAXILLÆ INFERIORIS.—The lower jaw-bone is likened to a horse-shoe, or to a crescent, or to the letter U, though we need be under no anxiety about resemblances for a form so generally known. There is such an infinite complication of parts surrounding the jaw, of glands, muscles, blood-vessels, and nerves, that it were endless to give even the slightest account of these. They shall be reserved each for its proper place, while I explain the form of the lower jaw, in the most simple and easy way. The lower jaw is divided into the chin, viz. the space betwixt the two mental foramina; the base, properly the sides, extending backward to the angle; and the upright portion of the bone.

The fore part, or chin, is in a handsome and manly face very square; and this portion is marked out by this squareness, and by two small holes, one on either side, by which the nerves of the lower jaw come out upon the face.

Chin.

The base of the jaw is a straight and even line, terminating the outline of the face. It is distinctly traced all along, from the first point of the chin, backwards to the angle of the jaw. Fractures of this bone are always more or less transverse, and are easily known by the falling down of one part of this even line, and by feeling the crashing bones when the fallen part is raised. Such fractures happen from blows or falls; but not by pulling teeth, for the sockets of the teeth bear but a small proportion to the rest of the jaw; even in children, this cannot happen; for in them the teeth have shorter roots, and have no hold nor dangerous power over the

Base.

jaw: though (as I have said) the sockets often suffer, the jaw itself never yields.

Angle. The angle of the jaw is that corner where the base of the jaw ends, where the bone rises upwards, at right angles, to be articulated with the head. On the upright branch, as it is termed, we see the impressions of the masseter muscle. This part, also, is easily felt, and by it we judge well of the situation of veins, arteries, and glands, which might be in danger of being cut, in wounds or in operations. There are two processes of the jaw of particular importance, the coronoid or horn-like process, for the insertion of its strong muscles, especially of the temporal muscle, and the condyloid or hinge-process, by which it is jointed with the temporal bone.

1. Coronoid process. The CORONOID PROCESS, named from its resemblance to a horn, is, like the rest of the jaw-bone, flat on its sides, and turned up with an acute angle, very sharp at its point, and, when the bone is in its place, lying exactly under the zygoma or temporal arch. The temporal muscle runs under this arch, and lays hold on the coronary process, not touching it on one point only, but grasping it on every side, and all round. And the process is set so far before the articulation of the jaw, that it gives the muscle great power. This process is so defended by the temporal arch, and so covered by muscles, that it cannot be felt from without.

2. Condyloid process. The CONDYLOID PROCESS, or the articulating process of the jaw, is behind this. This also is of the same flat form with the rest of the jaw. The condyle, or joint of the jaw-bone, is placed upon the top of the rising branch, and has a lengthened Cervix. neck. The condyle, or articulating head, is not round, but flat, of a long form, and set across the branch of the jaw. This articulating process is received into a long hollow of the temporal bone, just under the root of the zygomatic process; so that by the long form of the condyles, and of the cavity into which it is received, this joint is a mere hinge, not admitting of lateral nor rotatory motions, at least of

no wider lateral motions than those which are necessary in grinding the food; but the hinge of the jaw is a complex and very curious one, which shall be explained in its proper place. The line of continuation between these two last processes forms what is called the semi-lunar notch. Semi-lunar notch.

The ALVEOLAR PROCESS, or the long range of sockets for the teeth, resembles that of the upper jaw. The jaw, as the body grows, is slowly increasing in length, and the teeth are added in proportion to the growth of the jaws. When the jaws have acquired their full size, the sockets are completely filled; the lips are extended, and the mouth is truly formed. In the decline of life the teeth fall out, and the sockets are re-absorbed, and carried clean away, as if they had never been; so that the chin projects, the cheeks become hollow, and the lips fall in, the surest marks of old age. 3. Alveolar process.

The SPINA INTERNA, or internal tubercle of the lower jaw, is just behind the symphysis, or on the inside of the circle of the chin. It gives origin to muscles which move the tongue and larynx. On the inside of the lateral portion of the jaw, we observe an oblique ridge for the attachment of the mylo-hyoideus. On the inside of the angle, the bone is rough for the attachment of the pterygoid muscle. 4. Spina interna. 5. Linea interna. 6. Roughness for the attachment of the pterygoid muscles.

The successive changes of the form of the jaw are worthy of being mentioned once more. First, That in the child the jaw consists of two bones, which are joined slightly together in the chin. This joining, or symphysis, as it is called, is easily hurt, so that in preternatural labours it is, according to the common method of pulling by the chin, always in danger, and often broken. During childhood the processes are blunt and short, do not turn upwards with a bold and acute angle, but go off obliquely from the body of the bone. The teeth are not rooted, but sticking superficially in the alveolar process; and another set lies under them, ready to push them from the jaws. Symphysis.

Secondly, That in youth the alveolar process is extending, the teeth are increasing in number. The coronoid and articulating processes are growing acute and large, and are set off at right angles from the bone. The teeth are now firmly rooted; for the second set has come up from the body of the jaw.

Thirdly, In manhood the alveolar process is still more elongated. The dentes sapientiæ are added to the number of the teeth; but often, by this, the jaw is too full, and this last tooth coming up from the backmost point of the alveolar process in either jaw, it sometimes happens that the jaw cannot easily close; the new tooth gives pain; it either corrupts, or it needs to be drawn.

Fourthly, In old age the jaw once more falls flat; it shrinks, according to the judgment of the eye, to half its size; the sockets are absorbed, and conveyed away; and in old age the coronoid process rises at a more acute angle from the jaw-bone, and by the falling down of the alveolar process, the coronoid process seems increased in length.

HOLES. — The holes of the jaw are chiefly two:

7. Internal maxillary hole. A LARGE HOLE on the inner side, and above the angle of the jaw, just at the point where these two branches, the condyloid and the coronoid processes, part. A wide groove, from above downwards, leads to the hole; and the hole is, as it were, defended by a small point, or pike of bone, rising up from its margin. This is the GREAT HOLE for admitting the LOWER MAXILLARY NERVE into the hollow of the jaw, where it goes round within the circle of the jaw, distributing its nerves to all the teeth. But at the point where this chief branch of the nerve goes down into the jaw, another branch of the nerve goes forward to the tongue. And as nerves make an impression as deep as that of arteries in a bone, we find here two grooves, first, one marking the great nerve, as it advances towards its hole; and secondly, a smaller groove, marking the course of the lesser

8. Impression of nerves.

branch, as it leaves the trunk, and passes this hole to go forward to the tongue.

Along with this nerve the lower maxillary artery, a large branch, enters also by the hole; and both the nerve and the artery, after having gone round the canal of the jaw, emerge again upon the chin.

The second hole of the lower jaw is that on the side of the chin, which permits the remains of the great nerve and artery (almost expended upon the teeth) to come out upon the chin: it is named the MENTAL HOLE. 9. Mental hole.

REVIEW OF THE SKELETON.

ALTHOUGH we are obliged to study the parts of the human body separately, in what we choose to call systems, as the bones, the muscles, the blood-vessels, yet these in nature form one system, and have the most intimate correspondence. The bones correspond with the muscular parts; and as the strength of the muscular frame distinguishes the male, so the male skeleton is marked by stronger and heavier bones, where all the processes and tubercles are more distinctly marked. It is for the same reason that the skeleton of an athletic man is valuable, because, corresponding with the fulness and symmetry of the muscular frame, that activity which has perfected the moving parts, has added distinctness to all the points of demonstration of the bones. It is a correspondence of the same kind which accounts for the bones of a man suddenly cut off in the vigour of health and exercise, being hard as ivory, compared with the bones of one who has lived an indolent life, or has long lain in sickness.

The skeleton of woman is further distinguished from that of man: 1. By the depth of the vertebræ; 2. The narrowness of the lower part of the thorax; 3. The sternum shorter, and more projecting; 4. The diameters of the pelvis greater; the sacrum more hollow, as well as broader; the os coccygis slender and more flexible at its articulation; 5. The aceta-

bula more distant; 6. The thigh bones more oblique in their position under the body; 7. The feet small, and the toes more pointed outward; 8. The bones of the face smaller, and the cavities less developed. To these some add a peculiarity in the sagittal sutures, since the lateral divisions of the os frontis are joined later than in man.

As to the height of the human skeleton, we have, in the collections in London, skeletons of the natural form, varying from eight feet two inches to thirty-five inches in height. However we may account for the giant height, that of the dwarf is undoubtedly from disease, a diseased limitation of the growth of the whole body, which we sometimes see in individual parts of the body.

In reviewing the general form of the skeleton, we are naturally called to observe the SPINE.

When we contemplate the mechanism of the skull, we shall find that for protecting the brain its form is perfect, secure on all sides, and strengthened where the exposure to injury is the greatest. The spinal column, which sustains the skull, has equal provisions for the security of the brain; and, what is most admirable, there is an entirely different principle introduced here; for whereas in the head, the whole aim is firmness in the joinings of the bones, in the spine which supports the head, the object to be attained is mobility or pliancy. In the head, each bone is firmly secured to another; in the spine the bones are not permitted to touch: there is interposed a soft and elastic material, which takes off the jar that would result from the contact of the bones. We shall consider this subject a little more in detail.

The spinal column, as it is called, serves three purposes: it is the great bond of union betwixt all the parts of the skeleton; it forms a tube for the lodgment of the spinal marrow, a part of the nervous system as important to life as the brain itself; and lastly, it is a column to sustain the head.

We now see the importance of the spine, and we

shall explain how the various offices are provided for.

If the protection of the spinal marrow had been the only object of this structure, it is natural to infer that it would have been a strong and unyielding tube of bone; but, as it must yield to the inflexions of the body, it cannot be constituted in so strict an analogy with the skull. It must, therefore, bend; but it must have no abrupt or considerable bending at one part; for the spinal marrow within would in this way suffer.

By this consideration we perceive why there are twenty-four bones in the spine, each bending a little; each articulated or making a joint with its fellow; all yielding in a slight degree, and, consequently, permitting in the whole spine that flexibility necessary to the motions of the body. It is next to be observed that, whilst the spine by this provision moves in every direction, it gains a property which belongs more to our present purpose to understand. At each interstice between the vertebræ there is a peculiar elastic gristly substance, which is squeezed out from betwixt the bones, and permits them to approach and play a little in the motions of the body. This gristly substance is enclosed in an elastic binding, or membrane of great strength, which passes from the edge or border of one vertebra to the border of the one next it. When a weight is upon the body, the soft gristle is pressed out, and the membrane yields: the moment the weight is removed, the membranes recoil by their elasticity, the gristle is pressed into its place, and the bones resume their position.

We can readily understand how great the influence of these twenty-four joinings must be in giving elasticity to the whole column; and how much this must tend to the protection of the brain. Were it not for this interposition of elastic material, every motion of the body would produce a jar to the delicate texture of the brain, and we should suffer almost as much in alighting on our feet as in falling on our

head. It is, on the same principle, necessary for the builder to interpose thin plates of lead or slate between the different pieces of a column to prevent the edges (technically called arrises) of the cylinders from coming in contact, as they would, in that case, chip or split off.

But there is another very curious provision for the protection of the brain: we mean the curved form of the spine. If a steel spring, perfectly straight, be pressed betwixt the hands from its extremities, it will resist, notwithstanding its elasticity, and when it does give way, it will be with a jerk. Such would be the effect on the spine if it stood upright, one bone perpendicular to another; for then the weight would bear equally; the spine would yield neither to one side nor to the other; and, consequently, there would be a resistance from the pressure on all sides being balanced. We, therefore, see the great advantage resulting from the human spine being in the form of an italic *f*. It is prepared to yield in the direction of its curves; the pressure is of necessity more upon one side of the column than on the other; and its elasticity is immediately in operation without a jerk. It yields, recoils, and so forms the most perfect spring; admirably calculated to carry the head without jar, or injury of any kind. The most unhappy illustration of all this is the condition of old age. The tables of the skull are then consolidated; and the spine is rigid: if an old man should fall with his head upon the carpet, the blow, which would be of no consequence to the elastic frame of a child, may to him prove fatal; and the rigidity of the spine makes every step which he takes vibrate to the interior of the head, and jar on the brain.

We may observe, that the spine of an infant is not so pyramidal as in the adult. It is some time before the vertebræ of the loins assume their just form. The spine of the infant is straight, compared to the column of the adult: by which we see that there is a growth, and gradual change in the con-

formation of the chain of bones, fitting them for the erect posture.

In the adult the direction of the lumbar vertebræ, forward from the sacrum, protects the spine in the motion of the body; for if the spine stood perpendicularly, its base would be jarred in advancing forwards. We may take the comparison betwixt the attachment of the spine to the pelvis, and the insertion of the mast of a ship into the hull. The mast goes directly through the decks without touching them, and the heel of the mast goes into the step, which is formed of large solid pieces of oak timber laid across the keelson. The keelson is an inner keel, resting upon the floor-timbers of the ship, and directly over the proper keel. These are contrivances for enlarging the base, on which the mast rests as a column: for, in proportion to the height and weight of a column, its base must be enlarged, or it would sink into the earth; and so, if the mast were to bear upon a point, it would break through the bottom of the ship.

The mast is supported upright by the shrouds and stays. The shrouds secure it against the lateral or rolling motion, and the stays and backstays against the pitching of the ship. These form what is termed the standing rigging. The mast does not bear upon the deck, or on the beams of the ship; indeed there is a space covered with canvas, betwixt the deck and the mast.

We often hear of a new ship going to sea to stretch her riggings; that is, to permit the shrouds and stays to be stretched by the motion of the ship, after which they are again braced tight: for if she were overtaken by a storm before this operation, and when the stays and shrouds were relaxed, the mast would lean against the upper deck, by which it would be sprung or carried away. Indeed, the greater proportion of masts that are lost, are lost in this manner. There are no boats which keep the sea in storms like those which navigate the gulf of Finland; their masts are not attached at all to the hull of the ship, but simply rest upon the step.

Although the spine has not a strict resemblance to the mast, the contrivances of the ship-builder, however different from the provisions of nature, show what is the object to be attained; and when we are thus made aware of what is necessary to the security of a column on a moveable base, we are prepared to appreciate the superior provisions of nature for giving security to the human spine.

The human spine rests on the *pelvis*, or basin; a circle of bones, of which the haunches are the extreme lateral parts; and the sacrum (which is as the keystone of the arch) is the central part. To this central bone of the arch of the pelvis the spine is connected; and, taking the similitude of the mast, the sacrum is as the *step* on which the base of the pillar, like the heel of the mast, is socketed or mortised. The spine is tied to the lateral parts of the pelvis by powerful ligaments, which may be compared to the shrouds. They secure the lower part of the spine against the shock of lateral motion or rolling; but, instead of the stays to limit the play of the spine forwards and backwards in pitching, or to adjust the rake of the mast, there is a very beautiful contrivance in the lower part of the column.

The spine forms here a semicircle, which has this effect; that, whether by the exertion of the lower extremities the spine is to be carried forward upon the pelvis, or whether the body stops suddenly in running, the jar which would necessarily take place at the lower part of the spine, C.* if it stood upright like a mast, is distributed over several of the bones of the spine; and, therefore, the chance of injury at any particular part is diminished.

For example, the sacrum, or centre bone of the pelvis, being carried forward, as when one is about to run, the force is communicated to the lowest bone of the spine. But, then, the surfaces of these bones stand with a very slight degree of obliquity to the line of motion; the shock communicated from the lower to the second bone of the vertebræ is still in a direction very nearly perpendicular to its surface

* See the woodcut, p. 166.

of contact. The same takes place in the communication of force from the second to the third, and from the third to the fourth; so that before the shock of the horizontal motion acts upon the perpendicular spine, it is distributed over four bones of that column, instead of the whole force being concentrated upon the joining of any two, as at C.

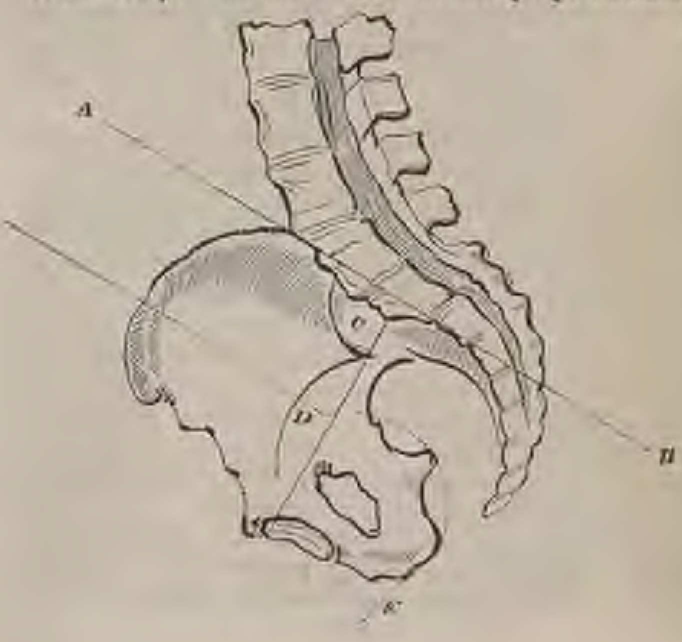
If the column stood upright, it would be jarred at the lowest point of contact with its base. But by forming a semicircle, the motion, which would produce a jar on the very lowest part of the column, is distributed over a considerable portion of the column; and in point of fact, this part of the spine never gives way.

In reviewing the building up of the column, there are three points which possess more extensive motion, and which, on that very account, are more subject to accident and to disease. The first is near the junction of the vertebræ of the back to those of the loins; for as the vertebræ of the back constitute the most unyielding part of the chain, where they terminate below, the flexibility of the adjoining piece must be the greater, and proportionally weaker — a fishing-rod breaks close to the joining, because the part joined is inflexible.

As some introduction to the study of the deformities of this column, we may observe the necessary consequence of growth and stature. We cannot fail to observe, that a little fat man carries himself perpendicularly, throwing the body backward, as it were, briskly, for which he is accused of conceit; when it is no more than balancing the anterior weight of his belly, by throwing back the trunk and shoulders. And so the *incessus* of a pregnant woman is stately, and she is accused of carrying her burden proudly, when, it may be, there is more shame than pride; yet she must throw the body back, to poise the increased weight of her condition. It is upon the same principle, that parents have so much trouble with a tall and thin young person, who naturally stoops, since the spine and head are always brought

to bear perpendicularly over the sacrum; and the want of filling up, and consequent comparative deficiency of weight in front, makes the head and shoulders project forward. The spine, being a flexible column, produces that consent through the whole body, to which the eye is familiar, without our seeking to account for it. The stiff knee, and the erect position of the head, correspond, just as the relaxed knees, and the pelvis projecting backwards in old age, is accompanied with the curve in the back and the stoop of the neck and shoulders. These natural consequences should be well considered by those who append weights to young people to correct their carriage, when they should be attending to the conformation and the natural exercise of the trunk and limbs.

It has been explained how the PELVIS stands, as an arch betwixt the spine and the lower extremities. From the term pelvis, and from the manner in which the student has these collected bones demonstrated to *him*, *he* is apt to forget how they stand in relation to the body. If a line were drawn perpendicularly



from the centre of the brim of the pelvis, that line would come through the umbilicus. If that line were carried through the cavity of the pelvis, equidistant from the sacrum and pubis in all its course, it would form a curve D E; and this curved line, passing through the pelvis, is properly the axis of the pelvis. It is the line in which the child's head descends; it is the line in which instruments are used: the forceps in midwifery, the gorget in lithotomy; the trocar in puncturing the bladder must also be used with due regard to this line.

And now that the bones are contemplated in their natural relation, we see into what form the pelvis will be distorted, by the combined influence of rickets, pressure, and the progress of growth in the bones. The arch receives the pressure in three points; on the acetabula, where they rest on the thigh-bones, and on the sacrum, which, like the key-stone of an arch, closes the bones of the pelvis, and supports the column of the spine and the incumbent weight of the body. The consequence of this is, that the distorted pelvis assumes, most frequently, a triangular form. Sometimes, however, the ossa pubis are pressed in so uniformly as to give the pelvis a flattened form; and the accoucheur would do well to consider the form of the distorted pelvis, before he gives out his absolute rule, regarding what is to be done in certain degrees of diminished diameter in the brim and outlet of the pelvis.

OF THE CHEST.

In extending the parallel between the structure of the body and the works of human art, it signifies very little to what part we turn; for the happy adaptation of means to the end will every where call for our admiration, in exact proportion to our success in comprehending the provisions which Supreme Wisdom has made. We turn now to a short view of the bones of the chest.

The thorax, or chest, is composed of bones and

cartilages, so disposed as to sustain and protect the most vital parts, the heart and lungs, and to turn and twist with perfect facility in every motion of the body: and to be in incessant motion in the act of respiration, without a moment's interval during a whole life. In anatomical description, the thorax is formed of the vertebral column or spine, on the back part, the ribs on either side, and the breast-bone or sternum, on the fore part. But the thing most to be admired is the manner in which these bones are united, and especially the manner in which the ribs are joined to the breast-bone, by the interposition of cartilages, or gristle, — of a substance softer than bone, and more elastic and yielding. By this quality they are fitted for protecting the chest against the effects of violence, and even for sustaining life after the muscular power of respiration has become too feeble to continue without this support.

If the ribs were complete circles, formed of bone, and extending from the spine to the breast-bone, life would be endangered by any accidental blow; even the rubs and jolts to which the human frame is continually exposed, would be too much for their delicate and brittle texture. But these evils are avoided by the interposition of the elastic cartilage. On their fore part the ribs are eked out, and joined to the breast-bone by means of cartilages, of a form corresponding to that of the ribs, being, as it were, a completion of the arch of the rib, by a substance more adapted to yield in every shock or motion of the body. The elasticity of this portion subdues those shocks which would occasion the breaking of the ribs. We lean forward, or to one side, and the ribs accommodate themselves, not by a change of form in the bones, but by the bending or elasticity of the cartilages. A severe blow upon the ribs does not break them, because their extremities recoil and yield to the violence. It is only in youth, however, when the human frame is in perfection, that this pliancy and elasticity have full effect. When old age approaches, the cartilages of the ribs become bony.

They attach themselves firmly to the breast-bone, and the extremities of the ribs are fixed, as if the whole arch were formed of bone unyielding and inelastic. Then every violent blow upon the side is attended with fracture of the rib, an accident seldom occurring in childhood, or in youth.

But there is a purpose still more important to be accomplished by means of the elastic structure of the ribs. This is in the action of breathing, especially in the more highly-raised respiration which is necessary in great exertions of bodily strength, and in violent exercise. There are two acts of breathing—*expiration*, or the sending forth of the breath; and *inspiration*, or the drawing in of the breath. When the chest is at rest, it is neither in the state of expiration nor in that of inspiration; it is in an intermediate condition between these two acts. And the muscular effort by which either inspiration or expiration is produced, is an act in opposition to the elastic property of the ribs. It is the property of the ribs to preserve the breast in that intermediate state between expiration and inspiration. The muscles of respiration are excited alternately, to dilate or to contract the cavity of the chest, and, in doing so, to raise or to depress the ribs. Hence it is, that both in inspiration and in expiration the elasticity of the ribs is called into play; and, were it now within our province, it would be easy to show, that this property of the cartilages of the ribs preserves life, by respiration being continued after the vital muscular power, without such assistance, was too weak to carry it on.

It will at once be understood, from what has now been explained, how, in age, violent exertion is under restraint, in so far as it depends on respiration. The elasticity of the cartilages is gone, the circle of the ribs is now unyielding, and will not allow that high breathing, that sudden and great dilatation and contraction of the cavity of the chest, which is required for circulating the blood through the lungs, and relieving the heart amidst the

more tumultuous flowing of the blood which exercise produces.

The thorax of the human skeleton is remarkable for its transverse diameter, its elevation and shortness*, and, consequently, for the large space betwixt the pelvis and margin of the chest, which gives a remarkable facility and extent to the motion of the human body. Quadrupeds have the thorax compressed laterally, with a projecting and lengthened sternum, so that the scapulæ rest on the sides of the thorax, and the fore legs stand perpendicularly under the chest.

OF THE EXTREMITIES.

There are a class of philosophers who conjoin, as necessary parts of the same plan, man's reason and the perfection of the hand, the one for council, the other for action. The peculiarity of the upper extremity, as distinguishing it from the lower extremity, is the smallness of the bones, the freedom of their articulations, and the great variety of motions attainable through the combination of the whole. As distinguished from the anterior extremity of brutes, we find its peculiarity principally in the perfect clavicle, in the great mobility of the scapula, and the lateral projection of the glenoid cavity; in the provision of the joint of the elbow for the co-operation of the hands, and in the perfect articulation of the twenty-nine bones of the carpus, metacarpus, and fingers; in the position of the bones, and in the strength of the muscles of the thumb. There is a sort of resemblance in the arrangement of the bones of the lower and upper extremities: but the solid junction of the bones of the leg, the firm building of the bones of the tarsus, and the strength and size and firmly wedged position of the metatarsal of the great toe, are in remarkable contrast with the free

* The horse has thirty-six ribs; there are thirty-two in the hyena; forty in the elephant.

rotatory motions of the radius, and the mobility of the thumb, and the freedom and extent of motion of the fingers.

The size and strength of the lower extremities at once declare the provision of the human skeleton for the upright position, and that there is no true biped but man. The admirable adaptation of all creatures to their condition, and the provision of monkeys and apes to climb and spring among the branches of trees, has given rise to long and useless speculations, not very creditable to philosophy. These creatures are of the class quadrumanus; their hind feet are as perfect instruments of prehension as their paws, which shows the limited object of their structure. A silly observation is copied through many books, that we owe the position of the toe to the dancing-master; but every thing in the shape of the bones of the lower extremity, and the insertion of the muscles, conform to this object; and it is that which gives elasticity, freedom, and, consequently, elegance to the motion of the body. How awkward is that man's gait who walks directly over his toes; and if a woman have one foot placed straight forward and the other pointed, you perceive the effect in the awkward motion of the whole of one side of the body compared with the other.

There are, in all, thirty-six bones in the foot; and the first question that naturally arises, is, Why should there be so many bones? The answer is, In order that there may be so many joints; for the structure of a joint not only permits motion, but bestows elasticity.

A joint consists of the union of two bones, of such a form as to permit the necessary motion; but they are not themselves in contact: each articulating surface is covered with cartilage, to prevent the jar which would result from the contact of the bones. This cartilage is elastic, and the celebrated Dr. Hunter discovered that the elasticity was in consequence of the numberless filaments being closely compacted, and extending from the surface of the bone, in such

a manner that every filament was perpendicular to the pressure made upon it. The surface of the articulating cartilage is perfectly smooth, and is lubricated by the fluid called *synovia*, a viscous or oily liquor. A delicate membrane extends from bone to bone, confining this lubricating fluid, and forming the boundary of what is termed the cavity of the joint, although, in fact, there is no unoccupied space. External to this capsule of the joint, there are strong ligaments going from point to point of the bones, and so ordered as to bind them together without preventing their proper motions. From this description of a single joint, we can easily conceive what a spring or elasticity is given to the foot, where thirty-six bones are jointed together.

The most obvious proof of contrivance is the junction of the foot to the bones of the leg at the ankle joint. The two bones of the leg, the *tibia* and the *fibula*, receive the great articulating bone of the foot (the *astragalus*) betwixt them. And the extremities of these bones of the leg project so as to form the outer and inner ankle. Now, when we step forward, and whilst the foot is raised, it rolls easily upon the ends of these bones, so that the toe may be directed according to the inequalities of the ground we are to tread upon; but when the foot is planted, and the body is carried forward perpendicularly over the foot, the joint of the leg and foot becomes fixed, and we have a steady base to rest upon. Notwithstanding this mobility of the foot in some positions, when the weight of the body bears directly over it, it becomes so immoveable that the bones of the leg must be fractured before it yields.

We next observe, that, in walking, the heel first touches the ground. If the bones of the leg were perpendicular over the part which first touches the ground, we should come down with a sudden jolt, instead of which we descend in a semicircle, the centre of which is the point of the heel. And when the toes have come to the ground we are far from

losing the advantages of the structure of the foot, since we stand upon an elastic arch, the hinder extremity of which is the heel, and the anterior the balls of the toes. A finely formed foot should be high in the instep. The walk of opera dancers is neither natural nor beautiful; but the surprising exercises which they perform give to the joints of the foot a freedom of motion almost like that of the hand. We have seen the dancers, in their morning exercises, stand for twenty minutes on the extremities of their toes; after which the effort is made to bend the inner ankle down to the floor, in preparation for the Bolero step. By such unnatural postures and exercises the foot is made unfit for walking, as may be observed in any of the retired dancers and old *figurantes*. By standing so much upon the toes, the human foot is converted to something more resembling that of a quadruped, where the heel never reaches the ground, and where the paw is nothing more than the phalanges of the toes.

This arch of the foot, from the heel to the toe, has the astragalus resembling the keystone of an arch; but, instead of being fixed, as in masonry, it plays freely betwixt two bones, and from these two bones, the os calcis and os naviculare, a strong elastic ligament is extended, on which it rests, sinking or rising as the weight of the body bears upon it, or is taken off, and this it is enabled to do by the action of the ligament which runs under it.

This is the same elastic ligament which runs extensively along the back of the horse's hind leg and foot, and gives the fine spring to it, but which is sometimes ruptured by the exertion of the animal in a leap, producing irrecoverable lameness.

Having understood that the arch of the foot is perfect from the heel to the toe, we have next to observe, that there is an arch from side to side; for when a transverse section is made of the bones of the foot, the exposed surface presents a perfect arch of wedges, regularly formed like the stones of an arch in masonry. If we look down upon the bones of the

foot, we shall see that they form a complete circle horizontally, leaving a space in their centre. These bones thus form three different arches — forward; across; and horizontally: they are wedged together, and bound by ligaments. And this is what we alluded to when we said that the foundations of the Eddystone lighthouse were not laid on a better principle; but our admiration is more excited in observing, that the bones of the foot are not only wedged together, like the courses of stone, for resistance, but that solidity is combined with elasticity and lightness.

How much system there is in every thing belonging to an animal body, and what relation there is established through the whole skeleton, we may learn from the following considerations.

What we have now to state has been the result of the studies of many naturalists; of men who have laboured in the department of comparative anatomy, but have failed to seize upon it with the privilege of genius, and to handle it in the masterly manner of Cuvier.

Suppose a man ignorant of anatomy picks up a bone in an unexplored country, he learns nothing, except that some animal has lived and died there; but the anatomist can, by that single bone, estimate, not merely the size of the animal, as well as if he saw the print of its foot, but the form and joints of the skeleton, the structure of its jaws and teeth, the nature of its food, and its internal economy. This, to one ignorant of the subject, must appear wonderful, but it is after this manner that the anatomist proceeds: let us suppose that he has taken up that portion of bone in the limb of the quadruped which corresponds to the human wrist; and that he finds that the form of the bone does not admit of free motion in various directions, like the paw of the carnivorous creature. It is obvious, by the structure of the part, that the limb must have been merely for supporting the animal, and for progression, and not for seizing prey. This leads him to the fact that

there were no bones resembling those of the hand and fingers, or those of the claws of the tiger; for the motions which that conformation of bones permits in the paw would be useless without the rotation of the wrist — he concludes that these bones were formed in one mass, like the cannon-bone, pastern-bone, and coffin-bones of the horse's foot. *

The motion limited to flexion and extension of the foot of a hoofed animal implies a restrained motion in the shoulder joint; and thus the naturalist, from the specimen in his hand, obtains a very perfect notion of all the bones of the anterior extremity! The motions of the extremities imply a condition of the spine which unites them. Each bone of the spine will have that form which permits the bounding of the stag, or the galloping of the horse, but it will not have that form of joining which admits the turning or writhing of the spine, as in the leopard or the tiger.

And now he comes to the head: — the teeth of a carnivorous animal, he says, would be useless to rend prey, unless there were claws to hold it, and a mobility of the extremities like the hand, to grasp it. He considers, therefore, that the teeth must have been for bruising herbs, and the back teeth for grinding. The socketing of these teeth in the jaw gives a peculiar form to these bones, and the muscles which move them are also peculiar; in short, he forms a conception of the shape of the skull. From this point he may set out anew, for by the form of the teeth, he ascertains the nature of the stomach, the length of the intestines, and all the peculiarities which mark a vegetable feeder.

Thus the whole parts of the animal system are so connected with one another, that from one single bone or fragment of bone, be it of the jaw, or of the

* For these are solid bones, where it is difficult to recognise any resemblance to the carpus, metacarpus and bones of the fingers; and yet comparative anatomy proves that these moveable bones are of the same class with those in the solid hoof of the *belluæ* of Linnæus.

spine, or of the extremity, a really accurate conception of the shape, motions, and habits of the animal, may be formed.

It will readily be understood that the same process of reasoning will ascertain, from a small portion of a skeleton, the existence of a carnivorous animal, or of a fowl, or of a bat, or of a lizard, or of a fish; and what a conviction is here brought home to us, of the extent of that plan which adapts the members of every creature to its proper office, and yet exhibits a system extending through the whole range of animated beings, whose motions are conducted by the operation of muscles and bones!

After all, this is but a part of the wonders disclosed through the knowledge of a thing so despised as a fragment of bone. It carries us into another science; since the knowledge of the skeleton not only teaches us the classification of creatures, now alive, but affords proofs of the former existence of animated beings which are not now to be found on the surface of the earth. We are thus led to an unexpected conclusion from such premises; not merely the existence of an individual animal, or race of animals, but even the changes which the globe itself has undergone in times before all existing records, and before the creation of human beings to inhabit the earth, are opened to our contemplation.

REVIEW OF THE BONES OF THE CRANIUM, &c.

It requires no disquisition to prove that the brain is the most essential organ of the animal system, and being so, we may presume that it must be especially protected. We are now to inquire how this main object is attained?

We must first understand that the brain may be hurt, not only by sharp bodies touching and entering it, but by a blow upon the head which shall vibrate through it, without the instrument piercing the skull.

Indeed, a blow upon a man's head, by a body which shall cause a vibration through the substance of the brain, may more effectually deprive him of sense and motion than if an axe or a sword penetrated into the substance of the brain itself.

Supposing that a man's ingenuity were to be exercised in contriving a protection to the brain, he must perceive that if the case were soft, it would be too easily pierced; that if it were of a glassy nature, it would be chipped and cracked; that if it were of a substance like metal, it would ring and vibrate, and communicate the concussion to the brain.

Further thoughts might suggest, that whilst the case should be made firm to resist a sharp point, the vibrations of that circular case might be prevented by lining it with a softer material; just as no bell can vibrate having such an incumbrance; its sound is stopped like the ringing of a glass by the touch of a finger.

If a soldier's head be covered with a steel cap, the blow of a sword which does not penetrate will yet bring him to the ground by the percussion which extends to the brain; therefore, the helmet is lined with leather, and covered with hair; for, although the hair is made an ornament, it is an essential part of the protection: we may see it in the head-piece of the Roman soldier, where all useless ornament, being despised as frivolous, was avoided as cumbrous.

We now perceive why the skull consists of two plates of bone, one external, which is fibrous and tough, and one internal, dense to such a degree that the anatomist calls it *tabula vitrea* (the glassy table.)

Nobody can suppose this to be accidental. It has just been stated, that the brain may be injured in two ways: a stone or a hammer may break the skull, and the depressed part of the bone injure the brain; whilst, on the other hand, a mallet struck upon the head will, without penetrating, effectually deprive the brain of its functions, by causing a vibration which runs round the skull and extends to every portion of its contents.

Were the skull, in its perfect or mature state, softer than it is, it would be like the skull of a child; were it harder than we find it is, it would be like that of an old man. In other words, as in the former it would be too easily pierced, so, in the latter, it would vibrate too sharply and produce concussion. The skull of an infant is a single layer of elastic bone; on the approach to manhood it separates into two tables; and in old age it again becomes consolidated. During the active years of man's life the skull is perfect: it then consists of two layers, united by a softer substance; the inner layer is brittle as glass, and calculated to resist any thing penetrating; the outer table is tough, to give consistence, and to stifle the vibration which would take place if the whole texture were uniform and like the inner table.

The distinction in the tables of the skull is of the utmost consequence to the surgeon: it explains what takes place in fracture of the skull, and affords him the principles upon which he performs the operation of trepan. Where a portion of the skull is driven in, owing to the greater brittleness of the inner table, the internal part is broken off to a greater extent than the outer. Thus it happens that the diameter of the inner table of the broken portion is greater than the diameter of the outer table: and the inner margin of the detached portion of bone shelves under the margin of the hole in the skull. It is necessary, therefore, that the hole in the skull should be enlarged, to bring out the detached portion of bone. From the same peculiarity of the two layers in the skull, the inner table of bone will be fractured when there is hardly any injury apparent on the outer table.

The alteration in the substance of the bones, and more particularly in the skull, is marvellously ordered to follow the changes in the mind of the creature, from the heedlessness of childhood to the caution of age, and even the helplessness of superannuation. The skull is soft and yielding at birth; during childhood it is elastic, and little liable to injury from concussion; and during youth, and up to the period of

maturity, the parts which come in contact with the ground are thicker, whilst the shock is dispersed towards the sutures which are still loose. But when, with advancing years, something tells us to give up feats of activity, and falls are less frequent, the bones lose that nature which would render concussion harmless, and at length the timidity of age teaches man that his structure is no longer adapted to active life.

We must understand the necessity of the double layer of the skull, in order to comprehend another very curious contrivance. The sutures are the lines of union of the several bones which form the cranium, and surround and protect the brain. These lines of union are called sutures (from the Latin word for sewing), because they resemble seams. If a workman were to inspect the joining of two of the bones of the cranium, he would admire the minute dove-tailing by which one portion of the bone is inserted into, and surrounded by, the other, whilst that other pushes its processes or juttings out between those of the first in the same manner, and the fibres of the two bones are thus interlaced, as you might interlace your fingers. But when you look to the internal surface, you see nothing of this kind; the bones are here laid simply in contact, and this line is called *harmonia*, or harmony: architects use the same term to imply the joining by masonry. Whilst the anatomists are thus curious in names, it is provoking to find them negligent of things more interesting. Having overlooked the reason of the difference in the tables of bone, they are consequently blind to the purpose of this difference of the outward and inward part of a suture.

Suppose a carpenter employed upon his own material, he would join a box with minute and regular indentations by dovetailing, because he knows that the material on which he works, from its softness and toughness, admits of such adjustment of its edges. The processes of the bone shoot into the opposite cavity with an exact resemblance to the foxtail wedge

of the carpenter — a kind of tenon and mortice when the pieces are small.

But if a workman in glass or marble were to inclose some precious thing, he would smooth the surfaces and unite them by cement, because, even if he could succeed in indenting the line of union, he knows that his material would chip off on the slightest vibration. The edges of the marble cylinders which form a column are, for the same reason, not permitted to come in contact; thin plates of lead are interposed to prevent the edges, technically termed *arrises*, from chipping off or splitting.

Now apply this principle to the skull. The outer softer tough table, which is like wood, is indented and dovetailed; the inner glassy table has its edges simply laid in contact. It is mortifying to see a course of bad reasoning obscure this beautiful subject. They say that the bone growing from its centre, and diverging, shoots its fibres betwixt those which come in an opposite direction; thus making one of the most curious provisions of nature a thing of accident. Is it not enough to ask such reasoners, why there is not a suture on the inside as well as on the out?

The junction of the bones of the head generally being thus exact, and like the most finished piece of cabinet work, let us next enquire, whether there be design or contrivance shown in the manner in which each bone is placed upon another.

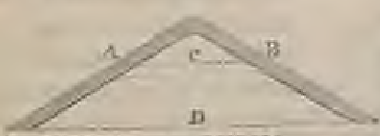
A. The *parietal* bone.
B. The *frontal* bone.
C. The *occipital* bone.
D. The *temporal* bone.
E. The *sphenoid* bone.

When we look upon the side of the skull thus, the temporal suture betwixt the bones A and D is formed in a peculiar manner; the lower or temporal bone laps over the superior or parietal bone. This,

too, has been misunderstood: that is to say, the plan of the building of the bones of the head has not been considered; and this joining, called the squamous suture, which is a species of scarfing, has been supposed a mere consequence of the pressure of the muscle which moves the jaw. Dr. Monro says, "the manner how I imagine this sort of suture is formed at these places, is, that by the action of the strong temporal muscles on one side, and by the pressure of the brain on the other, the bones are made so thin that they have not large enough surfaces opposed to each other to stop the extension of their fibres in length, and thus to cause the common serrated appearance of sutures; but the narrow edge of the one bone slides over the other."

The very name of the bones might suggest a better explanation. The ossa parietalia, the two large bones of a regular square shape, serve as walls to the interior or room of the head, where the brain is lodged. Did the reader ever notice how the walls of a house are assisted when thin and overburdened with a roof?

The *wall plate* is a portion of timber built into the wall, to which a transverse or tie-beam is attached by carpentry. This *cogging*, as it is termed, keeps the wall in the perpendicular, and prevents any lateral pressure of the roof. We sometimes see a more clumsy contrivance, a clasp, or a round plate of iron, upon the side of a wall; this has a screw going into the ends of a cross-beam, and by embracing a large portion of the brick-work, it holds the wall from shifting at this point. Or take the instance of a roof supported on inclined rafters, A B:—



Were they thus, without further security, placed upon the walls, the weight would tend to spur or press out the walls, which must be strong and heavy to support the roof; therefore, the skeleton of the roof is made into a *truss*, (for so the whole joined carpentry is called.) The upper cross-

beam marked by the dotted lines C, is a collar-beam, connecting the rafters of the roof, and stiffening them, and making the weight bear perpendicularly upon the walls. When the transverse beam joins the extremities of the rafters, as indicated by the lower outline D, it is called a *tie-beam,* and is more powerful still in preventing the rafters from pushing out the walls.

Now when a man bears a burden upon his head, the pressure, or horizontal push, comes upon the lower part of the *parietal bones,* and if they had not a tie-beam, they would, in fact, be spurred out, and the bones of the head be crushed down. But the temporal bone D, and still more, the sphenoid bone E, by running across the base of the skull, and having their edges lapping over the lower part of the great walls, or the parietal bones, lock them in as if they had iron plates, and answer the purpose of the tie-beam in the roof, or the iron plate in the walls. But the connexion is at the same time so secure, that these bones act equally as a straining piece, that is, as a piece of timber, preventing the tendency of the sides of the skull to each other.

It may be said, that the skull is not so much like the wall of a house as like the arch of a bridge: let us then consider it in this light.

We have here the two parietal bones, separated and resting against each other, so as to form an arch. In the centering, which is the wooden frame for supporting a stone arch while building, there are some principles that are applicable to the head.

We see that the arch formed by the two parietal bones is not a perfect semi-circle; there is a projection at the centre of each bone, the bone is more convex, and thicker at this part. The cause assigned for this is, that it is the

point from which ossification begins, and where it is, therefore, most perfect. But this is to admit a dangerous principle, that the forms of the bones are matter of chance: and thence we are left without a motive for study, and make no endeavour to comprehend the uses of parts. We find that all the parts which are most exposed to injury are thus strengthened; — the centre of the forehead, the projecting point of the skull behind, and the lateral centres of the parietal and frontal bones. The parts of the head which would strike upon the ground when the man falls, are the strongest, and the projecting arch of the parietal bone is a protection to the weaker temporal bone.

If we compare the skull to the *centering*, where a bridge is to be built over a navigable river, and consequently where the space must be free in the middle, we find that the scientific workmen are careful, by a transverse beam, to protect the points where the principal thrust will be made in carrying up the masonry: this beam does not act as a tie-beam, but as a straining-piece, preventing the arch from being crushed in at this point.

The necessity of strengthening certain points is well exhibited in the carpentry of roofs. In this figure it is clear, that the points A A will receive the pressure of the roof, and if the joining of the puncheons* and rafters be not secure, it will sink down in the form of the dotted line. The workmen would apply braces at these angles to strengthen them.

In the arch, and at the corresponding points of the parietal bones, the object is attained by strengthening these points by increase of their convexity and thickness; and where the workman would support

* The puncheons are the upright lateral pieces; the rafters are the timbers which lie oblique, and join the puncheons at AA.

the angles by braces, there are ridges of bone, in the calvaria *, or roof of the skull. If a stone arch fall, it must give way in two places at the same time; the centre cannot sink unless that part of the arch which springs from the pier yields: and in all arches, from the imperfect Roman arch to that built upon modern principles, the aim of the architect is to give security to this point.

In the Roman bridges still entire, the arch rises high, with little inclination at the lower part; and in bridges of a more modern date, we see a mass of masonry erected on the pier, sometimes assuming the form of ornament, sometimes of a tower or gateway, but obviously intended at the same time, by the perpendicular load, to resist the horizontal pressure of the arch. If this be omitted in more modern buildings, it is supplied by a finer art, which gives security to the masonry of the pier (to use the terms of anatomy), by its internal structure. In what is termed Gothic architecture, we see a flying buttress, springing from the outer wall, carried over the roof of the aisle, and abutting against the wall of the upper part, or *clere-story*. From the upright part of this masonry, a pinnacle is raised, which at first appears to be a mere ornament, but which is necessary, by its perpendicular weight, to counteract the horizontal thrust of the arch.

By all this, we see that if the skull is to be considered as an arch, and the parietal bones as forming that arch, they must be secured at the temporal and sphenoid † bones, the points from which they spring. And, in point of fact, where is it that the skull yields when a man falls, so as to strike the top of his head upon the ground? — in the temples. And yet the joinings are so secure, that the extremity of the bone does not start from its connexions. It must be frac-

* From the Latin *calva* or *calvaria*, a *helmet*.

† In the Greek, *sphenoid*—in the Latin, *cuneiform*—like a wedge, because it is wedged among the other bones of the head; but these processes, called wedges, are more like dovetails, which enter into the irregularities of the bones, and hold them locked.

tured before it is spurred out, and in that case only does the upper part of the arch yield.

But the best illustration of the form of the head is the dome.

A dome is a vault rising from a circular or elliptical base; and the human skull is, in fact, an elliptical surmounted dome, which latter term means that the dome is higher than the radius of its base. Taking this matter historically, we should presume that the dome was the most difficult piece of architecture, since the first dome erected appears to have been at Rome, in the reign of Augustus — the Pantheon, which is still entire. The dome of St. Sophia, in Constantinople, built in the time of the Emperor Justinian, fell three times during its erection: and the dome of the Cathedral of Florence stood unfinished 120 years for want of an architect. Yet we may, in one sense, say that every builder who tried it, as well as every labourer employed, had the most perfect model in his own head. It is obvious enough, that the weight of the upper part of the dome must disengage the stones from each other which form the lower circle, and tend to break up their joinings, and consequently to press or thrust outwards the circular wall on which it rests. No walls can support the weight, or rather the lateral thrust, unless each stone of the dome be soldered to another, or the whole hooped together and girded. The dome of St. Paul's has a very strong double iron chain, linked together, at the bottom of the cone; and several other lesser chains between that and the cupola, which may be seen in the section of St. Paul's engraved by Hooker.

The bones of the head are securely bound together, so that the anatomist finds, when every thing is gone, save the bone itself, and there is neither muscle, ligament, nor membrane of any kind, to connect the bones, they are still securely joined, and it requires his art to burst them asunder; and for this purpose he must employ a force which shall produce a uniform pressure from the centre outwards; and all the

sutures must receive the pressure at one time and equally, or they will not give way. And now is the time to observe another circumstance, which calls for our admiration. So little of accident is there in the joining of the bones, that the edge of a bone at the suture lies over the adjoining bone at one part and under it at another, which, with the dovetailing of the suture, as before described, holds each bone in its place firmly attached; and it is this which gives security to the dome of the cranium.

If we look at the skull in front, we may consider the orbits of the eye as crypts under the greater building. And these under-arches are groined, that is to say, there are strong arched spines of bone, which give strength sufficient to permit the interstices of the groinings, if I may so term them, to be very thin. Betwixt the eye and the brain, the bone is as thin as parchment; but if the anterior part of the skull had to rest on this, the foundation would be insufficient. This is the purpose of the strong ridge of bone which runs up like a buttress from the temple to the lateral part of the frontal bone, whilst the arch forming the upper part of the orbit is very strong: and these ridges of bone, when the skull is formed with what we call a due regard to security, give an extension to the forehead.*

In concluding this survey of the architecture of the head, let us suppose it so expanded that we could look upon it from within. In looking up to the vault, we should at once perceive the application of the *groin* in masonry; for the groin is that projection in the vault which results from the intersection of two arches running in different directions. One rib or groin extends from the centre of the frontal bone to the most projecting part of the occipital foramen, or opening on the back of the head; the other rib

* Although they are solid arches connected with the building of the cranium, and bear no relation to the surfaces of the brain, the early craniologists would have persuaded us that their forms correspond with the surfaces of the brain, and indicate particular capacities or talents.

crosses it from side to side of the occipital bone. The point of intersection of these two groins is the thickest and strongest part of the skull, and it is the most exposed, since it is the part of the head which would strike upon the ground when a man falls backwards.

What is termed the base of the skull is strengthened, if we may so express it, on the same principle: it is like a cylinder groin, where the rib of an arch does not terminate upon a buttress or pilaster, but is continued round in the completion of the circle. The base of the skull is irregular, and in many places thin and weak, but these arched spines or ribs give it strength to bear those shocks to which it is of course liable at the joining of the skull with the spine.

CRANIOLOGY.

We possess a very remarkable power of discriminating minute differences in the human countenance, and slight variations of expression, although we are so familiar with the exercise of this faculty, that it ceases to be surprising. There are varieties in the proportions of the head too, but we should be sadly puzzled to discover our best friends by the most careful inspection of their crania. While the design of producing a variety in the faces of men, and a power of expression, is obvious, it would be a useless provision if we did not also possess a corresponding capacity of minute observation of the human face. One source of this capacity is, that our sympathies are alive to every change of countenance; we are naturally or instinctively led to peruse those features, where every sentiment of the heart has a corresponding character displayed, which differ from the character of a language only in being transient. But if nature had intended that we should estimate the capacities or affections of our friends by a measurement of the skull, it is probable that she would not have covered the head with hair, nor have left our

hearts so little susceptible of impression from a bald one.

Whilst there is a never failing source of interest in the human countenance, it is probably conducive to our happiness that our opinions of men, drawn from this source, are not infallible. Yet disappointment, and unrequited affection or friendship, cannot erase that which is so deeply impressed on our natures: we nevertheless do not cease to scan the human features. Certain expressions go to our hearts, and we love not merely the expression of qualities, but the appropriate fitness of the countenance to express those qualities of mind which we love.

Whilst there is so much instinctive feeling, and such a mingling of accidental associations, in the formation of our opinions on the beauty and fitness of the human countenance, we must be liable to continual delusion; and this is the source of the popularity of works, in which the authors, like Lavater, have sought to connect the intellectual endowments with the features; or, like Gall, sought to discover the propensities of our natures in the lesser irregularities of our skulls. We have a natural propensity to examine the human countenance, and we do, in fact, possess a certain natural power of discrimination: we comprehend a part without the aid of teaching, and we yield ourselves to the delusion, that by the lights of physiology the sphere of our knowledge may be extended. But I apprehend that this faculty is of the nature of those instinctive powers that are matured early, and do not admit of unlimited improvement.

I may be permitted to touch upon a subject which has too much interested my countrymen; I mean the opinion of Dr. Gall, that the propensities of our nature may be ascertained by the protuberance of certain parts of the skull. I shall confine myself to the examination of the skull.

How far are the lesser convexities and irregularities of the human skull to be attributed to the peculiar form of the brain?

In my lectures it is necessary to give a severe or minute demonstration of the bones of the head; and for this purpose, I first exhibit the membrane, or little vesicle that surrounds the brain in the fœtus, before any bone is formed. I then demonstrate, that the several bones of the cranium are formed betwixt the layers of that membrane; and that they are necessarily adapted to the form of the brain previously existing; but when on that subject I take occasion to remark that a pregnant error has grown out of this demonstration, and one which, though blown out to the extent of a splendid folio, is only a more monstrous misconception. Some have contemplated this matter, as if the brain and skull were pieced together after the manner of a cunning artificer, and not formed as a perfect whole. Has not the skull those forms which best resist violence from without? Are not all the exposed parts strengthened, and is not the substance and the internal texture of the skull calculated to stop the vibrations that would be conveyed through a helmet differently constructed? This much I shall prove. I may then ask, is the brain, while it is yet exposed, and has no bony covering, formed with a relation to the case which is destined to cover it, or not? Look to the whole skeleton, and we shall find the answer; observe how the bones are formed in their just proportions to bear the weight, and to move in certain directions, long before they can be exposed to pressure, or put to use. How they are strengthened with spines wherever the force is destined to be applied; how curiously fashioned at their extremities to permit motion in the direction proper to the joint, and consistent with the movement of the whole limb. These provisions are made while the bones of the extremities are soft and transparent cartilages, and have not yet been put to their proper offices; and

shall the skull, which is intended to protect the noblest organ, be merely an accidental cast of the brain: and can it be supposed that its forms bear no relation to its proper office? This cannot be admitted; it must be granted, that the skull bears relation to external circumstances; and if this be so, must not the brain be formed with relation to the skull, and to such forms of the skull as are capable of protecting it? It follows, therefore, that although the skull be in close contact with the surface of the brain, and formed over it; yet if the external shape be obviously that which is best calculated to resist injury from without, we must conclude that the brain conforms to what is necessary in the shape of the skull; and although first formed, that it is bound up in that manner which shall best secure its protection by bone.*

But I shall prove further, that the lesser prominences of the skull, which are adding strength to it, result from circumstances quite independent of the brain, and ought not, therefore, to be brought forward as indications of propensities of the mind.

In contemplating the forms of the skull, the eye fixes naturally on the frontal bone, and on the slightest, as on the most careful inspection, it appears that the form of the bone on its lower part has relation to the orbits of the eyes, and the organ of smelling. It is evident, that but for the eyes there would be no orbits, no lateral ridge of the frontal bone, and no relative flatness of the temples; and but for the developement of the cavities of the nose, there would be nothing of that manly form which is so necessary to the perfection of the countenance; no support for the eyebrows, and no space for the muscles which move them; the flat insipidity of the child's forehead would be continued in after age.

Higher on the frontal bone, and on the upper division of the forehead, are two eminences, the

* All the viscera conform to a system of packing.

eminentiæ frontales. When natural, they give a fine variety of surface to the full and polished forehead; when not visible, there is a defect; when too prominent, there is a deformity. What are these? Are they indications of a corresponding prominence of the brain? by no means: they are obviously intended to give strength to these parts of the skull, which are much exposed; the bone is more raised and arched at these two parts; and that this is to afford protection, is demonstrated on making a section of the bone, for the frontal bone is thicker at these parts, and there is no concavity on the inside, to correspond with the external convexities. Let my reader here distinguish betwixt that opinion so long and generally acknowledged to have a foundation in nature; — that a full and high forehead indicates the perfection of the organ of the intellect; and these new opinions, that the lesser irregularities are produced by the greater developement of distinct organs in the brain. To the former opinion, I shall by experiments afford some support; the latter has no foundation.

Let us now direct our attention to the prominence of the parietal bone. If a man were to fall on the side of the head, the injury would be inflicted on the point of the utmost convexity, the lateral projection: and here, where the bone assumes the arched form of strength, we find that it is also increased in thickness. In this instance, as in the forehead, the outward convexity, or the elevation of the surface of the bone into a higher arch, bears no relation to the surface of the brain beneath.

Suppose, again, that we were to place a weight, accurately balanced, upon the top of the head; when the head was adjusted, so as to bear the weight with most ease, we should find that it was placed on the utmost convexity near the meeting of the coronal and sagittal sutures, where the bone rises into a fuller arch, I may say, the better to sustain the weight. We shall also find, on sawing the bone across here, that it is thicker, we must

presume for the same purpose that its convexity is increased, to give strength. I can have no doubt that this is a provision for bearing burdens on the head; and certainly the outer convexity has no relation to the form of the brain.

When we come round, in this examination, to the back of the head, we cannot fail to observe, that the occiput is least of all protected by the hands, and therefore we may presume that it is best protected by its form and thickness. The occipital bone is crossed with spines, which centre in a remarkable protuberance, which projects so as to meet the ground when we fall backwards. Besides, within, the occipital bone is in a manner groined, with crossing arches of bone, which add much to the strength of the skull at this part.

In short, after a general and unprejudiced inspection of the shape of the skull, we must believe that it is formed with reference to the pressure it has to sustain from without, or of resistance to external violence. If it be so, and the brain and skull are close in contact, the former must be constituted with reference to the latter. That the size and general dimensions of the cranium do correspond with the volume of the brain, there can be no doubt; but the lesser convexities have no such relation to the internal organ.

It is a strange delusion that would lead some men to believe, that, in the outward configuration of the skull, by which I mean the forms which have relation to the organs of sight, smell, and voice, and those spines and prominences which have respect to the strength of the skull, or to the attachment of muscles, they see the indications of particular properties of the mind, or the organs of certain propensities.

That the size of the brain-case, or the prevailing form of the whole head, may not have some relation to the perfection of the intellect, it would be bold to affirm. Most anatomists have believed that they have; but we must distinguish this question from

the speculations of Drs. Gall and Spurzheim, opinions which they have attempted to engraft upon the acknowledgment of men every way worthy of credit.

Varieties in the forms of the Head indicative of national peculiarities.

It is impossible to conceal from ourselves, that much theory, and a great deal of misplaced enthusiasm, has had an influence on the opinions of physiologists, regarding the varieties of mankind. It is, however, allowable to take as a principle, that there will be a relation betwixt vigour of intellect and perfection of form; and that, therefore, history will direct us to the original and chief family of mankind. We therefore ask, which are the nations that have excelled and figured in history, not only as conquerors, but as forwarding, by their improvements in arts and sciences, the progress of human knowledge?

It is not to be denied, that there are national peculiarities in the form of the skull, as there are of features, of colour, and of general form. These, in their extremes, are very distinct; but they are joined, as it were, by intermediate degrees of difference; and there are distinctions to be observed in the individuals of any one people, as great at least as those which mark national peculiarity. There are as great varieties among individuals of the tribes of America or of Africa, as among the nations of Asia or of Europe.

Among the ancient nations, one great character seems to have prevailed: the Assyrians, Chaldeans, Medes, Persians, Jews, the Greeks, and Romans, appear to have had their origin and centre in the Western part of Asia, perhaps betwixt the mountains of Caucasus and the Caspian Sea. To this day there is in the people seated there, Circassians and Georgians, a degree of beauty and perfection of form, that at least agrees with this hypothesis;

and from this, as the centre of the old Continent and of ancient nations, departure from a common form of the head and features is to be observed in all directions over the face of the globe. It is noticed as we depart eastward through Tartary, and to the extreme north-eastern parts of Asia even to America. Again, departing from the centre, we may descend south-east to the Peninsula of India, and the Asiatic Islands, and to those of the great Pacific Ocean. Or, on the other hand, we may trace a change towards Egypt and the African varieties; or lastly, towards the western extremities of Europe; where in the extreme islands of the west, there is a perfection of manly form and feminine beauty, happily combined with qualities still more to be esteemed, and which are now spread to the New Continent, and destined to characterize the larger portion of the inhabitants of our globe.

These varieties are distinguishable into five grand families: I. In the people seated betwixt Mount Caucasus and the Caspian, there is observed a due balance betwixt the cranium and bones of the face, that is a full developement of the cranium or brain-case, and, as we may suppose, a perfection in the organ of intellect; a due proportion betwixt the bones of the face, both in comparison with the cranium and amongst each other; so that the face is small, the outline smooth, the contour of the features regular, and there is no harshness from their undue prominence. With this there is combined beauty of the frame generally: long hair and fair skin, and blooming complexion, varying with emotion, and an index of the mind not to be neglected in estimating the perfection of the human body. This is the white variety of mankind, which spreads over Western Asia and Europe. The form of the skull is considered as the medium and more perfect form, betwixt the Mongolian races, in which the face is compressed, so as to be extended laterally, and the Ethiopian, which exhibits the jaws lengthened, and the face projecting from a receding forehead.

II. The Mongolian variety extends to the Calmucks, the Tungooses of China, and round by Siberia to the transition forms of the Esquimaux and the Greenlander. The cranium is globular, the bones of the face broad and flattened, the os frontis broad and flat, the malar bones projecting laterally, the orbits large and open, the superciliary ridges elevated, corresponding with the Calmuc countenance; the face is broad, the eyes are apart, and the space betwixt them flat, the aperture of the eyelids is narrow, and the nose round.

III. The third variety is the Ethiopian, and comprehends the well-known African skull. The head is the reverse of the globular form. The great peculiarity is not, as has been supposed, in the comparative size of the bones of the face, over the cranium, but merely in the size of the teeth and jaws, and the forms of the bones connected with the teeth in office, as giving origin to the muscles which move the jaws; and here I may observe, that whatever peculiarity of form may distinguish the teeth and jaws of any nation, there is always a correspondence in the soft parts placed over them, and hence the thick and fleshy lips, and the heavy cheeks of the African, are combined with their protuberant jaws and teeth.*

IV. The fourth variety includes the native Americans; and a race arriving from the eastern extremity of Asia may be traced down the North American continent, until it meets the natives of the South, the Caribbees or Caribs, who have the bones of the face broad, but not flat, prominent cheek bones, a short forehead, the eyes deep, and the bones of the nose developed, but the nose flattened.

V. The fifth is the Malay variety, which is intermediate betwixt the Asiatic and the Negro. It

* Some years ago I made a comparison betwixt the extreme forms of the European and Negro skull. This I did by suspending them on a rod introduced through the foramen magnum. I then compared their position and the inclination of the facial line. See the Philosophy of Expression, Second edition.

would appear as if mankind had spread more easily by the influence of the winds and the currents of the ocean, than by the regular progress of wandering tribes. The peculiarities under this head may be traced from the Red Sea, along the coasts of Hindoostan, through the Straits of Malacca, to the islands of Sumatra, Java, and the Celebes, to New Guinea, to New Holland, and Van Diemen's Land. The skull of a Buggess, from the island of Celebes, has the low forehead and the prominent jaws of the Negro, with the lateral projection of the face of the Mongolian variety, a combination which we might expect on looking to the map of Eastern Asia. Captain Cook has informed us, that among the Friendly Islanders, he met with hundreds of European faces, and "genuine Roman noses." In the islands of the Pacific Ocean, there is scope for the re-union of the families of mankind; arrivals from the North of the American Continent: men sprung from the natives of the Southern Continent of America: the Ethiopian extreme, floating through the Eastern Archipelago, and meeting the descending current of the maritime people of China, Corea, and Japan, form varieties and transitions. In the Marquesan, Society, Friendly, and Sandwich islands, the Caucasian variety prevails, and it meets in the New Hebrides and New Zealand with the tribes of New Guinea and New Holland.

OF THE FORMATION AND GROWTH OF BONES.*

It is not easy to explain, in their natural order, the various parts of which the human body is composed †; for they have that mutual

dependence upon each other, that continual circle of action and re-action in their various functions, and that intricacy of connection, and close dependence, in respect of the individual parts, that, as in a circle there is no point of preference from which we should begin to trace its course, so in the human body there is no function so insulated from the other functions, no part so independent of other parts, as to determine our choice. We cannot begin without hesitation, nor hope to proceed in any perfect course; yet, from whatever point we begin, we may so return to that point, as to represent truly this consent of functions, and connection of parts, by which it is composed into one perfect whole.

As dead parts, the bones are the most permanent, unchangeable parts of all the body; while as living parts, and partaking in the laws of the living system, their substance changes continually. We see them exposed to the seasons, without suffering the smallest

* I have arranged the preparations illustrative of the growth and structure of bone, so as to correspond with this dissertation. This referred to the collection which is now in the possession of the College of Surgeons of Edinburgh; but the series is complete in the Anatomical Museum in the London University.

† This figure represents the skeleton of the arm of the fœtus; it is dried, and while the cartilages have shrunk and become of a dark colour, the portions of the bones which have begun to form are visible in the scapula, clavicle, humerus, radius, and ulna, the metacarpal bones, and some of the phalanges of the fingers.

change; remaining for ages the memorials of the dead; the evidence of a former race of men, or of animals which have ceased to exist since the last great revolution of our globe; the proofs of such changes on our globe as we cannot trace but by these uncertain marks. It is from such circumstances that we are apt to conceive that, even in the living body, bones are hardly organized, scarcely partaking of life, not liable, like the soft parts, to disease and death. But minute anatomy, the most pleasing part of our science, unfolds and explains to us the internal structure of the bones; shows their myriads of vessels; and proves them to be as full of blood as the most succulent and fleshy parts, and as subject to change; having, like them, their periods of growth and decay; that they are more liable to accidents, and as subject to internal disease.

According to the chemists bone consists of albumen, a little jelly, and the earth of bone, the proper hardening material which gives the property of resistance.* This earth of bone consists of 82 parts in the hundred of phosphate of lime, the remainder containing fluate and carbonate of lime, with the phosphates of magnesia and soda.

I have a notion that some of these may be products arising out of the processes employed.

The phenomena of fractured bones first suggested some indistinct notions of the way in which bone might be formed. It was observed, that in very aged men, a hard crust was often formed upon the surface of the bones; that the fluid exuding into the joints of gouty people, sometimes coagulated into a chalky mass. Le Dran had thought that he had seen, in a case of scrophulous bone, an exudation which flowed out like wax, and hardened into perfect bone. Daventer, that he had seen the juice exuding

* M. Herissant has some merit in the investigation of this subject. See Memoires Acad. pour 1758, p. 322. Malpighi is considered to be the first who announced that the basis of bone was an animal matter, like cellular membrane.

from a split in a bone, coagulate into a bony crust; and they thought it particularly well ascertained, that callus was but a coagulable juice, which might be seen exuding directly from the broken ends, and which gradually coagulated into hard bone. The best physiologists did not scruple to believe, that bones, and the callus of broken bones, were formed of a bony juice, which was deposited by the vessels of the part, and which, passing through all the successive conditions of a thin uncoagulated juice, of a transparent cartilage, and of soft and flexible bone, became at last, by a slow coagulation, a firm, hard, and perfect bone, depending but little upon vessels or membranes, either for its generation or growth, or for nourishment in its perfect state. This opinion, erroneous as we now know it to be, once prevailed; and if other theories were at that time proposed, they did not vary in any very essential point from this first notion. De Heide, a surgeon of Amsterdam, believed that bone or callus was not formed from a coagulable juice, but from the blood itself. He broke the bones of animals, and examining them at various points of time, he never failed (like other speculators) to find exactly what he desired to find. "In every experiment" he found a great effusion of blood among the muscles, and round the broken bone; and he has easily traced this blood through all the stages of its progress. In the first day red and fluid; by and by coagulated; then gradually becoming white, then cartilaginous, and at last (by the exhalation of its thinner parts) hardening into perfect bone.

It is very singular that those who abjure theory, and appeal to experiments, who profess only to deliver facts, are least of all to be trusted; for it is theory which brings them to try experiments, and then the form and order, and even the result of such experiments, must bend to meet the theories which they were designed to prove: it is by this deception that the authors of two rival doctrines arrive at

opposite conclusions, by facts directly opposed to each other. Du Hamel believed, that as the bark formed the wood of a tree, adding, by a sort of secretion, successive layers to its growth, the periosteum* formed the bone at the first, renewed it when spoiled or cut away, and when broken, assumed the nature of bone, and repaired the breach. He broke the bones of pigeons, and, allowing them to heal, he found the periosteum to be the chief organ for re-producing bone. He found that the callus had no adhesion to the broken bone, was easily separated from the broken ends, which remained rough and bare; and, in pursuing these dissections, he found the periosteum fairly glued to the external surface of the new bone; or he found rather the callus or regenerated bone to be but a mere thickening of the periosteum, its layers being separated, and its substance swelled. On the first days he found the periosteum thickened, inflamed, and easily divided into many lamellæ or plates; but while the periosteum was suffering these changes, the bone was in no degree changed. On the following days, he found the tumour of the periosteum increased at the place of the fracture, and extending further along the bone; its internal surface already cartilaginous, and always tinged with a little blood, which came to it through the vessels of the marrow. He found the tumour of the periosteum spongy, and divisible into regular layers, while still the ends of the bone were unchanged, or only a little roughened by the first layer of the periosteum being already converted into earth, and deposited upon the surface of the bone: and in the next stage of its progress, he found the periosteum firmly attached to the surface of the callous mass. By wounding, not breaking the bones, he had a more flattering appearance still of a proof; for having pierced them with holes, he found the holes filled up with a sub-

* The periosteum is the membrane which surrounds and is attached to the surface of the bone, and which conveys the blood-vessels to it.

stance, proceeding from the periosteum, which was thickened all round them. In an early stage, this plug could, by drawing the periosteum, be pulled out from its hole: in a more advanced stage, it was inseparably united to the bone so as to supply the loss.

Haller, doubting whether the periosteum, a thin and delicate membrane, could form so large a mass of bone or callus, repeated the proofs, and he again found quite the reverse of all this: that the callus, or the original bone, was in no degree dependent on the periosteum, but was generated from the internal vessels of the bone itself; that the periosteum did indeed appear as early as the cartilage which is to produce the bone, seeming to bound the cartilage, and give it form; but that the periosteum was at first but a loose tissue of cellular substance, without the appearance of vessels, or any mark of blood, adhering chiefly to the heads or processes, while it hardly touched the body of the bone. He also found that the bone grew, became vascular, had a free circulation of red blood, and that then only the vessels of the periosteum began to carry red blood, or to adhere to the bone. We know that the bones begin to form in small nuclei, in the very centre of their cartilage, or in the very centre of the yet flexible callus, far from the surface, where they might be assisted by the periosteum; and here it is justice to add, that while these questions were agitated on the continent, Dr. William Hunter had proved that the callus of broken bones was organized, and that the secretion of bone into it proceeded from the arteries taking on them a new action, and secreting the earthy matter into the first formed substance.

Thus has the formation of bone been falsely attributed to a gelatinous effusion, gradually hardened; or to that blood which must be poured out from the ruptured vessels round the fractured bone; or to the induration and change of the periosteum, depositing layer after layer, till it completed the form of the bone.

But when, neglecting theory, we set ourselves to examine, with an unbiassed judgment, the process of nature in forming the bones, as in the chick, or in restoring them, as in broken limbs, a succession of phenomena present themselves, the most orderly, beautiful, and simple of any that are recorded in the philosophy of the animal body: for if bones were but condensed gluten, coagulated blood, or a mere deposition from the periosteum, they were then inorganized, and out of the system, not subject to change, nor open to disease; liable, indeed, to be broken, but without any means of being healed again; while they are, in truth, as fully organized, as permeable to the blood, as easily hurt, and as easily healed, as sensible to pain*, and as regularly changed as te softer parts are. We are not to refer the generation and growth of bone to any one part. It is not formed by that jelly in which the bone is laid, nor by the blood which is circulating in it, nor by the periosteum which covers it, nor by the medullary membrane with which it is lined; but the whole system of the bone, of which these are parts only, is designed and planned, is laid out in the very elements of the body, and goes on to ripeness, by the concurring action of all its parts. The arteries, veins, and lymphatics exist, in the cartilage or the membranes, before bone is formed. At a certain regular period, the arteries, by a determined action, deposit the bone; which is formed commonly in a bed of cartilage, as the bones of the leg or arm are; sometimes betwixt two layers of membrane, like the bones of the skull, where true cartilage is never seen.

My readers understand that cartilage is a substitute for bone in the early months of the fœtus; that at a regulated period in each bone, at a given point,

* The obscurity on this subject is from the neglect of defined terms. We shall presently see that the sensibility possessed by the bones, and the kind of pain to which they are subject, differs from the sensibility and pain of the skin and soft parts.

and in a perfectly regular manner, portions of the cartilage are absorbed, and bone deposited.

This cartilage never is hardened into bone; but, from the first, it is in itself an organized mass. It has its vessels, which are at first transparent, but which soon dilate; and whenever the red colour of the blood begins to appear in them, ossification very

quickly follows.* The first mark of ossification is an artery, which is seen running into the centre of the cartilage, in which the bone is to be formed. Other arteries soon appear, overtake the first, mix with it, and form a network of vessels; then a centre of ossification begins, stretching its rays according to the length of the bone, and then the cartilage begins to grow opaque, yellow, brittle; it will no longer bend, and the small nucleus of ossification is felt in the centre of the bone, and, when touched with a sharp point, is easily known by its gritty feel. Other points of ossification are successively formed; always the ossification is foretold by the spreading of the artery, and by the arrival of red blood. Every point of ossification has its little arteries, and each ossifying nucleus has so little dependence on the cartilage in which it is formed, that it is held to it by vessels only; and when the ossifying cartilage is cut into thin slices, and steeped in water till its arteries rot, the nucleus of ossification drops spontaneously from the cartilage, leaving the cartilage like a ring, with a smooth and regular hole where the bone lay. This is because the cartilage was a sub-

* This figure represents the tibia of a fœtus cut through. The central part (*diaphysis*) is already bony; but the extremities are yet cartilage. The red blood is, however, entering the arteries and veins in the cartilaginous extremities; and the black spots in the midst of the cartilage mark the beginning of ossification, and formation of the *epiphysis*.

stitute for the bone, and, because preparatory to the formation of the nucleus of bone, the cartilage is absorbed, and a bed prepared for the new formation.

The colour of each part of a bone is proportioned exactly to the degree in which its ossification is advanced. When ossification begins in the centre of the bone, redness also appears, indicating the presence of those vessels by which the bony matter is to be poured out. When the bony matter begins to accumulate, the red colour of those arteries is obscured, the centre of the bone becomes yellow or white, and the colour removes towards the ends of the bone. In the centre, the first colouring of the bone is a cloudy, diffused, and general red, because the vessels are profuse. Beyond that, at the edges of the first circle, the vessels are more scattered and asunder, distinct trunks are easily seen, forming a circle of radiated arteries, which point towards the heads of the bone. Beyond that, again, the cartilage is transparent and pure, as yet untouched with blood; the arteries have not reached it, and its ossification is not begun. Thus, a long bone, while forming, seems to be divided into seven various coloured zones. The central point of most perfect ossification is yellow and opaque. On either side of that, there is a zone of red: on either side of that, again, the vessels being more sparingly distributed, form a vascular zone, and the zone at either end is transparent cartilage.* The ossifica-

* It is curious to observe how completely vascular the bones of a chicken are before the ossifications have fairly begun; how the ossifications, being begun, overtake the arteries, and hide them, changing the transparent and vascular part of the bone into an opaque white; how, by peeling off the periosteum, bloody dots are seen, which show a living connection and commerce of vessels betwixt the periosteum and the bone; how, by tearing up the outer layers of the tender bone, the vascularity of the inner layers is again exposed, and the most beautiful proof of all is that of our common preparations, where, by filling with injection the arteries of an adult bone, by its nutritious vessels, and then corroding the bone with mineral acids, we dissolve the earth, leaving nothing but the transparent jelly, which restores it to its original cartilaginous state: and then the vessels appear in such profusion, that

tion follows the vessels, and buries and hides those vessels by which it is formed: the yellow and opaque part expands and spreads along the bone: the vessels advance towards the heads of the bones: the whole body of the bone becomes opaque, and there is left only a small vascular circle at each end; the heads are separated from the body of the bone by a thin cartilage, and the vessels of the centre, extending still towards the extremities of the bone, perforate that cartilage, pass into the head of the bone, and then its ossification also begins, and a small nucleus of ossification is formed in its centre. Thus the heads and the body are, at the first, distinct bones formed apart, joined by a cartilage, and not united till the age of fifteen or twenty years.

Now we know the difference of apophysis and epiphysis, for anatomists make a sort of juggle betwixt these names, as if they were engaged in important matters. The *apophysis* is a process, or projection of bone. The epiphysis is the distinct portion of the bone, which is formed in a distinct nucleus of bone, and becomes afterwards joined and incorporated with the main body of the bone, and may then be described as an apophysis.

It is more important a great deal to observe, that as the extremities of the long bones forming the articulations are joined to the bodies or shafts by cartilage in childhood and adolescence, they are subject to be torn off, and to present a very puzzling case, that is, a fracture without crepitus; for as the crepitus of the fractured bone arises from the irregularity of the broken ends, and as in this sort of fracture [or diastasis] the surfaces are smooth, the surgeon is liable to be deceived, and the patient to permanent lameness and distortion. I have some specimens in my museum of this accident.

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the bone may be compared in vascularity with the soft parts, and it is seen that its arteries were not annihilated, but its high vascularity only concealed by the deposition of the bony parts.

The vessels may be seen entering in one large trunk (the nutritious artery) into the middle of the bone.* From that centre they extend towards both ends, and the fibres of the bone extend in the same direction; there are furrows betwixt the rays, and the arteries run along in the furrows of the bone, as if the arteries were forming these ridges, secreting and pouring out the bony matter, every artery piling it up on each side to form its ridge; yet the arteries of a bone branch with freedom, and with the same seeming irregularity as in other parts of the body. The arteries do not exude their secretion from their sides, so as to pile up the ridge of bone in their course. The secretion is performed in their very extremities. The body of the bone is supplied by its own vessels; the heads of the bone are in part supplied by the extremities of the same trunks which perforate the dividing cartilage like a sieve: the periosteum adhering more firmly to the heads of the bone, brings assistant arteries from without, which meet the internal trunks, and assist the ossification; which, with every help, is not accomplished in many years.

It is by the action of the vessels that all the parts of the human body are formed, fluids and solids, each for its respective use: the blood is formed by the action of the vessels, and all the fluids are in their turn formed from the blood. We see in the chick, where there is no external source from which its red blood can be derived, that red blood is formed within its own system. Every animal system, as it grows, assimilates its food, and converts it to the animal nature, and so increases the quantity of its red blood: and as the red blood is thus prepared by the actions of the greater system, the actions of particular vessels prepare various parts: some to be added to the mass of solids, for the natural growth;

* This is an important point of demonstration, because the artery, though small, acquires importance from its place. See Demonstration of the Femur and of the Tibia.

others to supply the continual waste, or to allow new matter to be received; others to be discharged from the body as effete and hurtful, as the secretions into the intestines, and from the kidney and from the skin; others again to perform certain offices within the body, as saliva, bile, or pancreatic fluid. Thus the body is furnished with various apparatus for performing various offices, and for repairing the waste. These are the secretions, and the formation of bone is one of these. The plan of the whole body lies in the embryo, in perfect order, with all its forms and parts. Cartilage is laid in the place of bone, and preserves its form for the future bone, with all its apparatus of surrounding membranes, its heads, its processes, and its connection with the soft parts. The colourless arteries of this pellucid but organized mass of cartilage keep it in growth, extend, and yet preserve its form, and gradually enlarging in their own diameter, at last receive the entire blood.* Then the deposition of earthy matter begins. The bone is deposited in specks, which spread and meet and form themselves into perfect bone. While the bone is laid by arteries, the cartilage is conveyed away by the absorbing vessels; and while they convey away the superfluous cartilage, they model the bone into its due form, shape out its cavities, cancelli, and holes, remove the thinner parts of the cartilage, and harden it into due consistence.

If the organization of arteries and veins, arteries to deposit bone, and absorbents to take up the carti-

* Previous to the formation of bone, (or the preparation for it,) in the cartilage, there is no proof of there being vessels in it. But we presume, that the cartilage must have vessels, because it grows with the growth of the animal, previous to the formation of bone in it.

However, the change, previous to the deposition of bone, has not been very accurately noticed: the firm cartilage suffers a change: there is a tract from the circumference to the centre of it, in which the firm cartilage is dissolved, and in the spot where the first particle of bone is to be deposited, there is a little soft well of matter, different from the firm substance of the cartilage.

lage, and make room for the osseous matter, be necessary in the formation and growth, it is no less necessary for the life and health of the full formed bone. Its natural condition depends on the regular deposition and re-absorption, moulding and forming the parts; and by various degrees of action, bone is liable to inflame, ulcerate, and spoil, to become brittle by too much secreted earth, or to become soft by a deficient secretion, or by a greedy diseased absorption of its earthy parts. The cartilage is in itself a secretion, to which the full secretion of bone succeeds.

In the re-union of a fractured bone, we have to observe nearly the same phenomena which accompany its first formation.

The first effect is the tearing of the periosteum and surrounding cellular textures, and perhaps some part of the muscular substance. The consequence of which is, that the broken extremities are surrounded with coagulum of blood. The extravasated blood being absorbed, an effusion is poured out by the vessels of the broken bone. This matter is a regular secretion: it appears to the eye like a uniform jelly; but so does the embryo itself. It is bone in embryo, the membranes and vessels, arteries, veins, and absorbents, are in it; the arteriesof the surrounding parts do not shoot into it, but veins, as well as arteries and absorbents, inosculate with the vessels of this new formed matter; and whatever vessels may, by accidental contact, inosculate with this substance, whether coming from bone, muscles, or membrane, still bone is formed, because it is the destined constitution of the new formed mass, or rather of the vessels which are already in it to form bone.

If the broken limb be too much moved during the cure, then are the secreting arteries interrupted in their office, perfect bone is never formed, it remains a cartilage, and an unnatural joint is at length produced; but by injuring the bone the vessels are opened again, the process is renewed, and the bones unite; or even by rubbing, by stimulating, by merely

7

cutting the surrounding parts, the vessels are made active, and their secretion is renewed.* During all the process of ossification, the absorbents proportion their action; they remove the cartilage as the bone is laid; they continue removing the bony particles also, which the arteries continually renew.

Nothing can be more curious than this continual renovation and change of parts, even in the hardest bones. We are accustomed to say of the whole body, that it is daily changed; that the older particles are removed, and new ones supply their place; that the body is not now the same individual body that it was; but it could not be easily believed that we speak only by guess concerning the softer parts, what we know for certain of the bones. It was discovered by chance, that animals fed upon the refuse of the dyer's vats received so much of the colouring matter into the system, that the bones were tinged by the madder to a deep red, while the softer parts were unchanged; no tint remaining in the ligaments nor cartilages, membranes, vessels, nor nerves, not even in the delicate vessels of the eye. It was easy to distinguish by the microscope, that such colour was mixed with the bony matter, resided in the interstices only, but did not remain in the vessels of the bone, which, like those of all the body, had no tinge of red; while our injections again fill the vessels of the bone, make all their branches red, but do not affect the colours of the bony part. When madder is given to animals, withheld for some time, and then given again, the colour appears in their bones, is removed, and appears again with such a sudden change as proves a rapidity of deposition and absorption, exceeding all likelihood or belief. All the bones are tinged in twenty-four hours; in two or three days their colour is very deep; and if the madder be left off but for a few days, the red colour is entirely removed.

* Those principles become of the utmost importance in the practice of surgery.

This tinging of the bones with madder, was the great instrument in the hands of Du Hamel, for proving by demonstration, that it was by layers from the periosteum that the bone was formed; and how very far the mind is vitiated by this vanity of establishing a doctrine on facts, is too easily seen here. Du Hamel, believing that the periosteum deposited successive layers, which were added to the bone, it was his business to prove that the successive layers would be deposited alternately red, white, and red again, by giving a young animal madder, withholding it for a little while, and then beginning again to give it. Now, it is easy to foresee that this tinging of the lamellæ should correspond with the successive times in which the periosteum is able to deposit the layers of its substance, but Du Hamel very thoughtlessly makes his layers correspond only with the weeks or months in which his madder was given or withheld. It is easy to foresee also, that if madder be removed from the bones in a few days, (which he himself has often told us,) then his first layer, viz. of red bone, could not have waited for his layer of white to be laid above it, nor for a layer of red above that again, so that he should have been able to show successive layers: And if madder can so penetrate as to tinge all the bones that are already formed, then, though there might be first a tinged bone, then a white and colourless layer, whenever he proceeded to give madder for tinging a third layer, it would pervade all the bone, tinge the layer below, and reduce the whole into one tint. If a bone should increase by layers, thick enough to be visible, and of a distinct tint, and such layers be continually accumulated upon each other every week, what kind of a bone should this grow to? Yet such is the fascinating nature of a theory, that Du Hamel, unmindful of any interruptions like those, describes boldly his successive layers, carrying us through regular details, experiment after experiment, till at last he brings up his report to the amount of five successive layers, viz. two red layers, and three

10

white ones. And in one experiment he makes the tinge of the madder continue in the bones for six months, forming successive layers of red and white, although in an earlier experiment (which he must have forgotten in his hurry) he tells us, that by looking through the transparent part of a cock's wing, he had seen the tinge of the madder gradually leave the bones in not many days.

I have before me preparations in which we see three distinct layers; and of the general fact there can be no doubt. If I doubt the exhibition of six layers, yet we may draw the same important conclusion from three as from six. Mr. John Hunter said, that in the growth of bone, the inner part was absorbed, while the outer surface had addition; and that the whole bone did not extend, but that the extension of the shaft resulted from an addition to the extremity. But be it at the same time understood, that while the additional increment is on the surfaces and the extremities of the bone, the whole substance of the bone is submitting to change.

By these experiments with madder, one most important fact is proved to us; that the arteries and absorbents, acting in concert, alternately deposit and re-absorb the earthy particles, as fast as can be conceived of the soft parts, or even of the most moveable and fluctuating humours of the body. The absorption of the hardest bones is proved by daily observation; when a carious bone disappears before the integuments are opened; when a tumour, pressing upon a bone, destroys it; when an aneurism of the temporal artery destroys the skull; when aneurism of the heart beats open the thorax, destroying the sternum and ribs; when aneurism of the ham destroys the thigh-bone, tibia, and joint of the knee; when a tumour coming from within the head, forces its way through the bones of the skull; — in all these cases, since the bone cannot be annihilated, what can happen, but that it must be absorbed and conveyed away? If we should need any stronger proofs than these, we have mollities ossium, a disease by which,

in a few months, the bony system is entirely broken up, and conveyed away by a high action of the absorbents, with continual and deep-seated pain; a discharge of the earthy matter by the urine; a gradual softening of the bones, so that they bend under the weight of the body; the heels are turned up behind the head; the spine is crooked; the pelvis distorted; the breast crushed and bent in: and the functions, beginning to fall low, the patient, after a slow hectic fever, long and much suffering of pain and misery, expires, with all the bones distorted in a shocking degree, gelatinous, or nearly so, robbed of all their earthy parts, and so thoroughly softened as to be cut with the knife.*

Thus every bone has, like the soft parts, its arteries, veins, and absorbent vessels; and every bone has its nerves too. We see them entering into its substance in small threads, as on the surfaces of the frontal and parietal bones; we see them entering for particular purposes, by a large and peculiar hole, as the nerves which go into the jaws to reach the teeth: we find delicate nerves going into each bone along with its nutritious vessels; and yet we dare hardly believe the demonstration, since bones seem quite insensible and dead. We have no pain when the periosteum is rasped and scraped from a bone: we have no feeling when bones are cut in amputation, or when, in a broken limb, we cut off with pincers the protruding end of a bone: we feel no pain when a bone is trepanned, or when caustics are applied to it; and it has been always known, that the heated irons, which the old surgeons used so much, made no other impression than to excite a particular titillation and heat, rather pleasant than painful, running along the course of the bone. But there is a deception in all this. A bone may be exquisitely sensible, and yet give no pain; a paradox which is very easily explained. A bone may feel acutely, and yet

* See the examples of distortion in my former Collection, and in particular the skeleton of the woman who died in consequence of the Cæsarean operation.

not send its sensations to the brain. It is not fit that parts should feel in this sense, which are so continually exposed to shocks and blows, and all the accidents of life; which have to suffer all the motions which the other parts require. In this sense, the bones, the cartilages, ligaments, bursæ, and all the parts that relate to joints, are quite insensible and dead. A bone does not feel, or its feelings are not conveyed to the brain; but except in the absence of pain, it shows every mark of life. Scrape a bone, and its vessels bleed; cut or bore a bone, and its granulations sprout up; break a bone, and it will heal; or cut a piece of it away, and more bone will readily be produced; hurt it in any way, and it inflames; burn it, and it dies. This is a deep subject, but a very curious one. The meaning attached to common terms of speech are not applicable here; and hence the obscurity. We would require to define sensation, sensibility, and pain; the liability of the part to be injured and excited to inflame, and the perception of that injury. I come to this conclusion: — The sensation of pain is bestowed as a safeguard to the frame, forcing us to avoid whatever is hurtful. To this effect, sensibility varies in different parts, and in general, the sensibility of the more superficial parts being sufficient protection to the parts beneath, the deep parts are but little sensible. The sensibility possessed by the skin would not be sufficient protection to the eye; and it differs in kind as well as in degree. Experiments have been made by cutting and burning the bones and tendons, and the conclusion has been, that they were insensible. But when a man sprains his ankle-joint, he is in extreme pain, though he can easily satisfy himself that the pain he feels is not in the skin, but must be in the joint and tendons. It appears, then, that such parts, usually thought insensible, feel pain, and can propagate that pain to the sensorium; and further, that the peculiar sensibilities are so suited as to allow of the free and natural motion, and of the necessary degree of attrition, but are

bestowed for the purpose of making us avoid that degree of violence, which would endanger the texture or healthy function of the part.

We have further to understand, that if there be any doubt of the sensibility of a bone, it is only when it is in health; for when inflamed, it becomes exquisitely sensible. When the texture of a bone is loosened by inflammation, its feeling is roused; and the hidden sensibility of the bone rises up like a new property of its nature: and as the eye, the skin, and all feeling parts have their sensibility increased by disease, the bones, ligaments, bursæ, and all the parts whose feeling, during health, is obscure and hardly known, are roused to a degree of sensibility far surpassing the soft parts. The wound of a joint is indeed less painful at first, but when the inflammation comes, its sensibility is raised to a dreadful degree: the patient cries out with anguish. No pains are equal to those which belong to the bones and joints.

Ossification is a process which, at first, appears so rapid, that we should expect it to be soon complete; but it becomes in the end a slow and difficult process. It is rapid at first; it advances slowly after birth; it is not completed till the twentieth year; it is forwarded by health and strength, retarded by weakness and disease. In scrophula it is imperfect, because there is an imperfect assimilation of food, and the earth of bone is not furnished or not secreted into the bone; and so children become ricketty, the bones soften and swell at their heads, and bend under the weight of the body. And why should we be surprised, that carelessness of food or clothing, bad air, or languid health, should cause that dreadful disease, when more or less heat, during the incubation of a chick, prevents the growth of its bones; when the sickness of a creature, during our experiments, protracts the growth of callus; when, in the accidents of pregnancy, of profuse suppuration, or of languid health, the knitting of broken bones is delayed, or prevented quite?

This process, so difficult and slow, is assisted by every provision of nature. The progress of the whole is slow, that so long as the body increases in stature, the bones also may grow; but it is assisted in the individual parts, where some are slow, some rapid in their growth, some delayed, as the heads of joints, that their bones may be allowed to extend, and others hastened, as the pelvis, that it may acquire its perfect size early in life. Ossification is assisted by the softness of the cartilaginous bed in which the bone is formed; by those large and permeable vessels which carry easily the grosser parts of the blood; by a quick and powerful absorption, which all along is modelling the bone; and, most of all, by being formed in detached points, multiplied and crowded together, wherever much bone is required.

We have understood that the bones of the head have membranes as their substitutes, as the long

bones have cartilage. The ossification, for example, of the frontal or parietal bone begins in a point (as here represented); a few delicate meshes of bony matter are formed in the interstices of the membrane. The membrane is by this means split into two other membranes, we afterwards recognize under the names of pericranium and dura mater. In this figure we have the commencement of the one half of the frontal bone. On the extreme margin we see through the meshes or net-work of new bone;

but other layers of bone similar to this are superadded, and the interstices of the first layer being opposed to the wire-work of the second, a solid appearance and opacity is produced. In a further state of advancement the bone assumes this appearance, and the filaments diverge regularly from the centre, which was the original spot where the ossification commenced.

It is thus that in the bones * of the skull ossification goes from one or more central points, and the radiated fibres meet the radii of other ossifying points, or meet the edges of the next bone. The thick round bones which form the wrist and foot have one ossification in their centre, which is bounded by cartilage all round. The processes are often distinct ossifications joined to the bones, like their heads, and slowly consolidated with them into firm bones.

In the original cartilage of the long bones there is no hollow nor cavity; it is all one solid mass. When the ossification first appears, the cavity of the bone also begins, and extends with the ossification: at first the cavity is confined chiefly to the middle of the bone, and extends very slowly towards the ends. This cavity in the centre of the bone is at first smooth, covered with an internal membrane, containing the trunks and branchings of the nutritious vessels, which enter by a great hole in the

* The brain of the fœtus while of the size of a hazel-nut is invested with a membrane, in which there is as yet no speck of bone. In the third month the ossification of the cranial bones commence, and the first process exhibits a very beautiful net of ossific wire-work. In a circle, the diameter of which is half an inch, we see a perfect net-work, resembling a fine lace, or the meshes of a spider's web. Upon this first layer another is deposited, and this superimposed net-work of bone is finer than the first: the meshes being smaller and the bony matter more abundant. The holes of the second net are not opposite to those of the first, so that the eye no longer penetrates the bone, although the structure be quite light and porous. While the second and third layer of bone is deposited on the outside of the first, the inner layer is extending in threads diverging from the centre, betwixt which delicate processes of bone intervening ribs are formed irregularly, still resembling the texture of the spider's web; and the diverging line of bone, being the stronger, it appears as if the cranial bones formed in diverging radii, while the edge of the bone extends in fine net-work, like to the first formed speck of ossification.

It is further worthy of remark, that this is the texture of true bone, and that what are called morbid ossifications, as of the coats of arteries and other membranes, are merely the deposit of earthy matter without organic structure.

middle of the bone; and the cavity is traversed with divisions of its lining membrane, which, like a net-work of partitions, conduct its branches to all parts of the internal surface of the bone; and its nets, or meshes, are filled with a reddish and serous fluid in the young bone, but secrete and contain a perfect marrow in the adult bone.

In the middle of the bone the cavity is small, the walls thick, and having all their bony plates; the cells of net-work few, and large; but towards the ends the bone swells out, the cavity also is large; but it is not like that in the middle, a large tubular cavity: it is so crossed with lattice-work, with small interstices and cells, that it seems all one spongy mass of bone: and so many of the inner layers are separated, to form this profusion of cells, that the whole substance of the bone has degenerated into this lattice-work, leaving only a thin outward shell. This reticular form is what anatomists call the cancelli, lattice-work, net-work, or alveolar part of the bone: it is all lined with one delicate membrane, and inward partitions of the same lining membrane cover each division of the lattice-work, forming each cell into a distinct cavity. In these cavities, or cells, the marrow is secreted. The secretion is thin and bloody in children; it thickens as we advance in years; it is a dense oil or marrow in the adult. The marrow is firmer, and more perfect in the middle of the bone, and more thin and serous towards the spongy ends. The whole mass, when shaken out of the bone, is like a bunch of grapes, each hanging by its stalk. The globules, when seen with the microscope, are neat, round, and white, resembling small pearls; and each stalk is seen to be a small artery, which comes along the membrane of the cancelli, spreads its branches beautifully on the surface of the bag, and serves to secrete the marrow, each small twig of artery filling its peculiar cell. To this, an old anatomist added, that they had their contractile power, like the urinary bladder, for expelling

their contents; that they squeezed their marrow, by channels of communication, through and among the bony layers; and that their oil exuded into the joint, by nearly the same mechanism by which it got into the substance of the bone; which is now known to be pure fancy, and to have no foundation.

While the constitution of a bone was not at all understood, anatomists noted with particular care every trifling peculiarity in the forms or connections of its parts; and these lamellæ attracted particular notice. Malphigi had first observed the lamellated structure of bones, likening them to the leaves of a book. Gagliardi, who, like Hippocrates, went among the burial places of the city, to observe the bones there, found in a tomb, where the bones had been long exposed, a skull, the os frontis of which he could dissect into many layers, with the point of a pin.* He afterwards found various bones, from all parts of the body, thus decomposed; and he added to the doctrine of plates, that they were held together by minute processes, which, going from plate to plate, performed the offices of nails: these appeared to his imagination to be of four kinds, straight and inclined nails, crooked or hook-like, and some with small round heads, of the forms of bolts or pins.†

* There is no proof of the bones being lamellated. As to the exfoliation of bone, the dead portion is generally irregular in its thickness, and rugged on its inner surface. This exfoliation of bone is a process of the living bone, and the inner living surface recedes from the outer one by absorption of its particles, because that outer surface is injured or dead. The nature of the injury, or the depth to which the bone has become dead, determines the extent and form of the portion cast off. When a scale only is thrown off, it is because the bone is only dead upon the surface. In regard to the breaking up of the surface of the cranial bones, when they lie exposed, the scales are similar to those from stones or metals exposed to the influence of the air, and moisture, and varying temperature: the thickness and succession of exfoliations depend on the operation of the weather, not on the original formation of the bone. I have never seen heat produce a lamellated decomposition of bone.

† These nails Gagliardi imagined were no more than the little irregularities, risings, and hollows of the adjoining plates, by which they are connected.

Another notable discovery was the use of the holes, which are very easily seen through the substance of bones, and among their plates. They are, indeed, no more than the ways by which the vessels pass into the bones; but the older anatomists imagined them to be still more important, allowing the matter to transude through all the substance of the bone, and keep it soft. Now this notion of lubricating the earthy parts of a bone, like the common talk of fomentations to the internal parts of the body, is very mechanical, and very ignorant; for the internal parts of the body are both hot and moist of themselves, and neither heat nor moisture can reach them from without: the bone is already fully watered with arteries; it is moist in itself, and cannot be further moistened nor lubricated, unless by a fuller and quicker circulation of its blood. It must be preserved by that moisture only which exists in its substance, and must depend for its consistence upon its own constitution; upon the due mixing up of its membrane, cartilage, and earth. Every part is preserved in its due consistence by the vessels which supply it; and I should no more suppose fat necessary for preserving the moistness of a bone, than for preventing brittleness in the eye. This marrow is, perhaps, more an accidental deposition than we, at first sight, believe. We, indeed, find it in such a regularity of structure, as seems to indicate some very particular use; but we find the same structure exactly in the common fat of the body. When, as we advance in years, more fat is deposited in the omentum, or round the heart, we cannot entertain the absurd notion, of fat being needed in our old age, to lubricate the bowels or the heart; no more is the marrow (which is not found in the child,) accumulated in old age, for preventing brittleness of the bones.*

* If we look to the difference there is in the adipose membrane, we shall find it more apparent than real. The fat on the soles of the feet and palms of the hands is particularly firm, but this firmness results from the strong intertexture of filaments of a tendinous strength. The fat in the exposed parts of the limbs

The internal periosteum is that membrane which surrounds the marrow, and in the bags of which the marrow is formed and contained. It is more connected with the fat than with the bone; and in animals, can be drawn out entire from the cavity of the bone; but its chief use is to conduct the vessels which are to enter into the substance of the bone.

The periosteum, the outer membrane of bone, which was once referred to the dura mater*, is merely condensed cellular substance; of which kind of matter we now trace many varied forms and uses, for so close is the connection of the periosteum, tendons, ligaments, fasciæ, and bursæ, and so much are these parts alike in their nature and properties, that we reckon them but as varied forms of one common substance, serving for various uses in different parts. The periosteum consists of many layers, accumulated and condensed one above another: it adheres to the body of the bone by small points or processes, which dive into the substance of the outer layer, giving a firm adhesion to it, so as to bear the pulling of the great tendons, which are fixed rather into the periosteum than into the bone. It is also connected with the bone by innumerable vessels. The layers of the periosteum nearest to the bone are condensed and strong, and take a strong adhesion to the bone, that the vessels may be transmitted safe, and the fibres of this inner layer follow the longitudinal directions of the bony fibres. The periosteum is looser in its texture outwardly, where it is reticulated and lax, changing imperceptibly into the common cellular substance. There the fibres of the periosteum assume the directions of the muscles, tendons,

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is less firm, in the orbits of the eyes more delicate, but in the bones it lies in transparent membranes, and is quite soft and compressible. The difference, however, is only in the manner in which the bags containing the fat are bound up and protected: where the substance is exposed to pressure, it is firm; where it lies concealed, it is less so; but where it is altogether within the protection of the bones, the membranes are very delicate, and the fat takes the appearance of marrow.

* See what is said under the head of membranes.

or other parts which run over it. Any accident which spoils the bone of its periosteum, endangers the life of the bone itself. The surface of the bone becomes first affected, and then it exfoliates; the accidental wounds of the periosteum, deep ulcers of the soft parts, as on the shin, the beating of aneurisms, the growth of tumours, the pressure even of any external body, will, by hurting the periosteum, cause exfoliation.

The cartilages are also a part of the living system of the bone; and we see too well, in the question of the bones themselves, how unphilosophical it must be, to deny organization and feeling to any part of the living body, however dead or insulated it may appear; for every part has its degree of life; the eye, the skin, the flesh, the tendons, and the bones, have successive degrees of feeling and circulation. We see, that where even the lowest of these, the bone, is deprived of its small portion of life, it becomes a foreign body, and is thrown off from the healthy parts, as a gangrened limb is separated from the sound body; and we speak as familiarly of the death of a bone, as of the gangrene of soft parts. How, then, should we deny organization and life to the cartilages? Though surely, in respect of feeling, they must stand in the very last degree.

We now understand the constitution of a bone, and can compare it fairly with the soft parts in vascularity, and in feeling; in quickness of absorption; in the regular supply of blood necessary to the life of the bony system; in the certain death of a bone, when deprived of blood by any injury of its marrow, or of its periosteum, as a limb dies of gangrene, when its arteries are cut or tied; in the continual action of its absorbents, forming its cavity, shaping its processes and heads, keeping it sound and in good health, and regulating the degree of bony matter, that the composition may neither be too brittle nor too soft. From this constitution of a bone, we could easily foresee how the callus for uniting broken bones must be formed; not by a mere coagulation of extra-

vasated juice, but by a new organization resembling the original bone.

The primordium of all the parts of the body is a thin coagulated mass, in which the forms of the parts are laid; and the preparation for healing wounds, and for every new part that needs to be formed, is a secretion of a fluid which coagulates, which is soon animated by vessels coming into it from every point. In every external wound, in every internal inflammation, wherever external parts are to be healed, or internal viscera are about to adhere, matter of this kind is secreted, which serves as a bed or nidus, in which the vessels spread from point to point, till the part is fully organized, and it is in this manner that the heart, the intestines, the testicle, and other parts, adhere by inflammation to the coats which surround them, and which are naturally loose. It is by a process not dissimilar that the broken ends of bones unite.

When we find the substance of the oldest bone thus full of vessels, why should we doubt its being able, from its own peculiar vessels, to heal a breach, or to repair any loss? How little the constitution of a bone has been understood, we may know from the strange debates which have subsisted so long about the proper organ for generating callus. Some have pronounced it to be the periosteum; others the medullary vessel, and internal membrane; others the substance of the bone itself. In the heat of this dispute, one of the most eminent anatomists produced a diseased bone, where a new bone was formed surrounding a carious one, and the spoiled bone rattled within the cavity of the sound one: here we should have been ready to pronounce, that bone could be formed by the periosteum only. But presently another anatomist produced the very reverse, viz. a sound young bone, forming in the hollow cylinder of a bone which had been long dead; where, of course, the callous matter must have been poured into the empty cavity of the spoiled bone, from the ends which still remained sound, or must have been secreted by the medullary vessels. But the truth is,

that callus may be thus produced from any part of the system of a bone.* If we pierce the bone of any animal, and destroy the marrow, the old bone dies, and a new one is formed around the old: if we kill the creature early, we find the new bone to be a mere secretion from the old bone; and if we wait the completion of the process, we find the new bone beautiful, white, easily injected, and thick, loose in its texture, and vascular and bloody, but still firm enough for the animal to walk upon; and in the heart of it we find the old bone, and that it has become dead and black.† If we reverse this operation, and destroy the periosteum only, leaving the nutritious vessels entire, then the new bone is formed fresh and vascular by the medullary vessels, and the old one, quite black and dead, surrounds it.‡

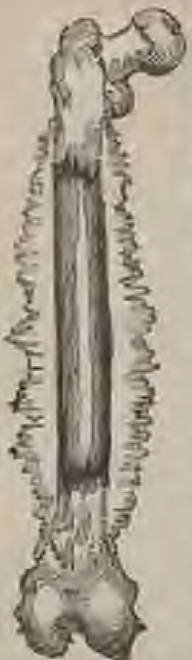
The effect of injury to a living bone is very curious. But the manner in which the bone resumes its pristine form is still more worthy of observation. At first, the outward exfoliation is attended with a proportionate filling up of the cavity of the bone: and the injury to the centre and body of the bone produces a new bone around the old one, and the old one at last dies, and is absorbed or discharged. But after years these changes are again reversed, and the new bone contracts

* In the experiments and observations which I have made, neither the periosteum or marrow seemed to have formed the bone; and I conclude, that nothing but bone can form bone, by the continuation of natural actions: and that in the case of *necrosis*, the old bone inflames and begins the new formation, before the continued irritation in the centre kills it. C. B.

† The figure represents the necrosed bone, the new bone, soft and irregular around the old.

‡ When I injured the marrow of the bone, necrosis was the consequence. When I deprived the bone of its periosteum and sur-

its diameter, and the cavity becomes of its natural dimensions, so that the evidence of the changes which



the bone has undergone are quite removed. This is a very beautiful example of the influence of that principle which controuls the growth of all the parts of the body, which may have its operation deranged by violent injury or by disease; but which will at last, by slow degrees, restore the part to its natural form and action.*

The diseases of the bones are the most frequent in surgery; and it is impossible to express how much the surgeon is concerned in obtaining true ideas of the structure, constitution, and diseases of bones; how tedious, how painful, and how loathsome they are; how often the patient may lose his limb, or endanger his life; how very useful art is; but, above all, what wonders nature daily performs in recovering bones from their diseased state.

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rounded it with a bit of bladder, I found the whole surface exfoliated, and the cavity of the bone filled up; but this was not a consequence of the destruction of the vessels of the periosteum, but of the contact of foreign matter with the surface of the bone. An effect precisely similar is the consequence of the sloughing of the soft parts over a bone, for the dead slough lying on the surface of the bone causes an exfoliation. C. B.

* This figure is a plan of necrosis. The shaft of the old bone is dark; the new bone is in outline; and now we perceive how the new bone encloses the old, and how it forms the medium of union betwixt the two extremities, after the old bone is loose or altogether cast out.

OF THE TEETH.

The structure, and growth, and decay of the teeth, are subjects of considerable interest.

Considering the teeth generally, as belonging to man and brutes, they are for masticating the food; they are for retaining the prey; they are weapons of defence; in some classes they are for digging and searching for food; and in some animals we can see no other use than for defending the eyes, as in the sus æthiopicus. Nor are we to consider them as exclusively belonging to the jaws, for they are sometimes seated in the back part of the mouth; and in fishes we find them in the beginning of the œsophagus, or at its termination, as in the crab and lobster.

The teeth differ from common bone: they are not only harder, but they are covered with a peculiar substance, the enamel, which is not found elsewhere in the body: though they stand exposed, they do not suffer as bone would do in the same circumstances; though worn by friction, they are not excited to diseased action; their mode of formation is peculiar, and so is the manner of their decay: and all these instances of their being different from common bone are so many reasons for instituting a distinct enquiry into their structure.

These peculiarities impose the necessity of a double set of teeth, since they cannot accommodate themselves by growth to the increasing size and strength of the jaws; it follows, that they must yield in succession, and that a double set be provided. The first set is called the milk teeth, or deciduous set of teeth; the second, the adult teeth. We shall begin this description with the perfect adult teeth.

DESCRIPTION OF THE HUMAN ADULT TEETH.

There are thirty-two teeth in the adult skull. These are divided into classes, according to their form and use. There are eight *incisores;* four *cuspidati*, or canine teeth; eight *bicuspides;* and twelve *molares*, or grinding teeth.

Every tooth has three parts; the crown, neck, and fang or root.

INCISORES. — The crown of the incisor tooth is a wedge, having its anterior and posterior surface inclined and meeting in a sharp edge. On the fore-part the surface is convex; on the inside the surface is concave; and viewing the tooth laterally, it is broader and flat near the neck, and rising pyramidal towards the cutting edge. The cortex or enamel covers the crown of the tooth; it descends on the back and anterior surface further than on the side. The fangs of the incisores are long and straight, and of a pyramidal form, so that they are deeply socketed in the jaw.

From their position in the jaw, the upper incisor teeth project more than the lower, and in chewing their edges do not meet. They pass each other so as to cut, and yet do not meet, and this prevents the rapid wasting of the edge which would otherwise take place, as we see in the horse.*

The incisor teeth of the horse, being subject to attrition, have a provision against this, in the cavity lined with enamel, which is observed in their centre; nevertheless, we see them worn down even below the bottom of that cavity; thus the surface of the tooth becomes smooth, and the horse loses the mark.

In some animals, as in the rodentia, the front teeth are still better formed for cutting; but as they suffer attrition, in order to preserve the outer edge sharp, they have a peculiar structure. They are so

* And as, indeed, we sometimes see in the human teeth.

deeply socketed, that they reach the whole length of the jaw, and they are provided with a continual growth from behind, which pushes the tooth out in proportion as it is worn away on the fore part. The enamel in these animals is more accumulated on the anterior edge of the tooth, so that the edge stands up fine and sharp.

The CUSPIDATI, OR CANINE TEETH, are next in order, counting backwards. They are two in number in each jaw. They have a general resemblance to the incisor teeth, for when their points are worn off, they are hardly distinguishable. Their fangs are longer, and being the corner teeth of the jaw, and deeply socketed, they form the strength of the front teeth. Their principal distinction is in the form of the upper part of the crown, which is like a spear, having a point with two lateral shoulders.

In the larger carnivorous mammalia, this order of teeth is of terrific length, whilst the front teeth are small and carved. The spiral tusk of the narwhal and the tusks of the walrus belong to this division of the teeth: so do the tusks of the babyroussa, which turn up in a spiral direction. The use of these teeth Blumenbach cannot comprehend, but Sir Everard Home conceives, that they are provided to defend the eyes of the animal as it rushes through the underwood. There is a small imperfect tooth, called the tush, in a horse, which belongs to this order of teeth, as it is placed betwixt the incisors and the grinding teeth.

The BICUSPIDES are four in each jaw: they stand betwixt the canine teeth and the grinding teeth, and in form are intermediate between these two orders. They are sometimes called the lesser molares, being in truth grinding teeth. The crown of the bicuspis rises in two sharp points, so that they are like two cuspidati incorporated, and their fangs prove this to be the case; for whilst they are always flatter and shorter than those of the cuspidati, they have often a division, and sometimes there are distinctly two

fangs: their roots are oftener curved than those of the other teeth. The second bicuspis is sometimes wanting.

MOLARES, OR GRINDING TEETH, are six in each jaw. The form of the crown is an oblong square. They have four or more projections on their upper surface, and they are covered with enamel to a uniform level, and form indeed an approximation to the graminivorous tooth, since these regular projections being covered with enamel, a portion of the enamel remains in the depressions when the projections have been worn down; and this is sufficient in a certain degree to save the remaining part of the tooth from wasting rapidly under attrition. The lower grinders have two separate fangs, and those of the upper jaw three.

The molares are best considered as cuspidati united, in which idea four cuspidati are incorporated to form one grinder. The projections on the grinding surface correspond with the points of the cuspidati, and the fangs correspond with the projections of the crown; for although there are only two or three roots to each grinding tooth, yet we may discover that there would be always four fangs if they were disjoined.

The term grinder is not good in comparative anatomy, for in brutes of prey they are compressed, and terminate in three sharp processes, and these in the closing of the jaw intersect each other like the blades of scissars.

These four orders make the full number of thirty-two teeth in the adult jaws.

On the whole the teeth of man are peculiar, in being on a level, and being more nearly of one length than any instance which we observe in brutes. In all other animals the teeth differ remarkably in the length and size of their different classes; and they are separated by wider intervals: another peculiarity is the upright position of the incisors, and the regular inclination of the whole lateral phalanx, in

proportion as they are distant from the centre of motion in the condyle of the jaw. It is indeed quite obvious that the front teeth have a use in speech, and therefore are different in man from those of animals. But there is a peculiarity in the molares also, in their obtuse tubercles, which exhibits a correspondence betwixt the teeth, taken collectively, and the variety of food and the mixed diet which is natural to man.

OF THE FIRST SET OF THE TEETH, THE MILK OR DECIDUOUS TEETH.

The first set of teeth are twenty in number: these are divided into three classes; the INCISORES, four in each jaw; the CUSPIDATI, two in each jaw; and the MOLARES, four in each jaw.

The teeth of a child generally appear in this order: first the central incisores of the lower jaw pierce the gum. In a month after, perhaps, their counterparts appear in the upper jaw. These in a few weeks are succeeded by the lateral incisores of the lower jaw; then the lateral incisores of the upper jaw, though sometimes the lateral incisores of the upper jaw appear before those of the lower jaw. The growth of the teeth is not after this in a regular progression backwards; for now, instead of the cuspidati, which are immediately lateral to the incisores, the anterior molares of the lower jaw show their white surface above the gum about the fourteenth or fifteenth month. Then the cuspidati pierce the gum; and, lastly, the larger molares make their appearance, the teeth of the lower jaw preceding those above. The last tooth does not rise till the beginning of the third year. *

* The figure exhibits a section of the lower jaw, at that period when the milk teeth have all risen, and when the permanent teeth are preparing in the jaw.

The teeth do not always cut the gums in this order; but it is the more regular and common order. When the teeth appear in irregular succession, more irritation and pain, and more of those symptoms which are usually attributed to teething, are said to accompany them.

The deciduous set of teeth are perfected with the rising of the second molaris; for the third molaris being formed about the eighth year, when the jaw is advanced towards its perfect form, is not shed, but is truly the first permanent tooth. The molares of the adult are properly the permanent teeth, (IMMUTABILES), for they alone arise in this part of the jaw, and remain in their original places; yet we must recollect that, in opposition to Albinus, in this arrangement, it is more common to speak of the whole set of the adult teeth as the *immutabiles.*

In the sixth and seventh years the jaws have so much enlarged, that the first set of teeth seems too small, spaces are left betwixt them, and they begin to fall out, giving place to the adult teeth. But the shedding of the teeth is by no means regular in regard to time; the child is already no longer in a state of nature, and a thousand circumstances have secretly affected the health and growth. The teeth even fall out three years earlier in one child than in another: nay, so frequently are some of them retained altogether, that it would appear necessary to be assured of the forward state of the adult tooth before the tooth of the first set should be thoughtlessly drawn.

The jaw-bones are still so small, that the second set of teeth must rise slowly and in succession, else they would be crowded into too small a circle, and of course turned from their proper direction.

The incisores of the under jaw are loose commonly when the anterior of the permanent molares are thrusting up the gum. The permanent central incisores soon after appear, and in two or three months more those of the upper jaw appear. In three or four months the lateral incisores of the lower jaw are loose, and the permanent teeth appear at the same time with the anterior molares. The lateral incisores of the upper jaw follow next; and in from six to twelve months more, the temporary molares loosen, the long fangs of the cuspidati retaining their hold some time longer.

The anterior molares and the cuspidati falling, are succeeded about the ninth year by the second of the bicuspides and the cuspidati. The posterior of the bicuspides take place of the anterior of the molares about the tenth or eleventh year; the second permanent molaris does not appear for five or six years from the commencement of the appearance of the permanent teeth. The jaw acquires its full proportion about the age of eighteen or twenty, when the third molaris, or the *dens sapientiæ*, makes its appearance. This tooth is shorter and smaller, and is inclined more inward than the others. Its fangs are less regular and distinct, being often squeezed together. From the cuspidati to the last grinder, the fangs are becoming much shorter, and from the first incisor to the last grinder, the teeth stand less out from the sockets and gums.

OF THE STRUCTURE OF THE TEETH.

A tooth consists of these parts:—The ENAMEL (A), a peculiarly hard layer of matter composing the sur-

face of the body of the tooth. The internal part, or bone of the tooth (B), is less stony and hard than the enamel, but of a firmer structure and more compact than common bone. In regard to the form of the tooth, we may observe, that it is divided into the crown, the neck, and the fangs, or roots of the tooth, which go deep into the jaw. There is a cavity in the body of the tooth (C), and the tube of the fangs communicates with it. This cavity receives vessels for supplying the remains of that substance upon which the tooth was originally formed. The roots of the teeth are received into the jaw by that kind of articulation which was called gomphosis. They are not firmly wedged into the bone, for in consequence of maceration, and the destruction of the soft parts, the teeth drop from the skull. There is betwixt the tooth and its socket in the jaw a common periosteum.

Of the enamel.—The surface of a tooth, that which appears above the gum, is covered with a very dense hard layer of matter, which has been called the enamel.* In this term there is some degree of impropriety, as assimilating an animal production with a vitreous substance, although the enamel very widely differs from the glassy fracture when broken. This matter bestows the most essential quality of hardness on the teeth; and when the enamel is broken off, and the body of the tooth exposed, the bony part quickly decays.

The enamel is the hardest production of the animal body; it strikes fire with steel. In church-yard skulls it is observed to remain undecayed when

* This section of the tooth is a plan; for in our preparations we make the bone black by burning, to exhibit the enamel contrasted with it. In this figure the bone is white, and the enamel black.

In brutes there is a considerable variety in the relative form of the enamel and bone of the tooth, but it is always laid with reference to the friction against the tooth, and so as to protect it from the effects of attrition.

the centre of the tooth has fallen into dust. It has been found that the component parts of the enamel are nearly the same with those of bone. In bone, the phosphate of lime is deposited on the membranes, or cartilage, but this hardening matter of bones is a secretion from the vessels of the part, and is accumulated around the vessels themselves: it is still within the controul of their action, and is suffering that succession of changes peculiar to a living part. In the enamel, the phosphate of lime has been deposited in union with a portion of animal gluten, and has no vascularity, nor does it suffer any change from the influence of the living system. Although the hardening matter be principally phosphate of lime, a small proportion of the carbonate of lime enters into the composition both of bone and of enamel. But in enamel, according to Morichini and Gay Lussac, there is fluat of lime, to which ingredient these chemists attribute the hardness of this crust. *

* By Mr. Hatchett's Experiments, (Philos. Transact. 1799.) we learn that bone consists of phosphate of lime, with a small proportion of carbonate of lime. The shell of the crab and lobster consist of phosphate of lime and carbonate of lime, the latter being in the greatest quantity. The testaceous shells consist entirely of carbonate of lime. The matter of bone and teeth consists of phosphate of lime and a small portion of carbonate deposited in the interstice of an animal substance, which is of the nature of cartilage, and proves to be gelatine. The bones of fish differ from those of man and brutes, in the larger proportion of animal substance. These chemical facts are, however, of little import to the anatomist: he is desirous of knowing what property of life these parts are endowed with; whether they are formed by a final deposition, or are still under the influence of the circulating vessels, whether they possess a principle of self-preservation independent of vascularity, or are like common dead matter altogether out of the system.

The formation of bone has been very fully described. The formation of shell is more like that of teeth. The testaceous shell consists of layers; the layers are formed successively by secretion from the animal body, and each successive layer is broader than the preceding, answering to the increased circumference of the animal. Reaumur broke the shell of a snail, and he found that when he covered the surface of the creature and prevented the exudation, no shell was formed.

Although we call the earthy deposit the hardening matter, yet it is the union of the glutinous matter which bestows the extreme hardness; for, when the tooth is as yet within the jaw, and in an early stage of its formation, the deposition is soft, and its surface rough; but, by a change of action in the secreting surface, which throws out this fluid, the first deposition is penetrated with a secretion, which either by this penetration simply, or by causing a new apposition of its parts, (its structure, indeed, looks like crystallization,) bestows the density and extreme hardness on the crust or enamel.

When an animal is fed with madder, the colouring matter coming, in the course of the circulation, in contact with the earth of bone, is attracted by it, and is deposited upon it in a beautiful red colour. This colouring matter penetrates more than injection can be made to do in the dead body; and, as by this process of feeding, the enamel is not tinged, we have a convincing proof that the vascular system has no operation on the enamel after it is formed.

In the marmot, beaver, and squirrel, the enamel is of a nut-brown colour, on the anterior surface of the incisor teeth. The molares of some of the cloven-hoofed animals are covered with a black vitreous matter, and sometimes they have a crust of a shining substance like bronze. In the grinding teeth of the graminivorous animals, the arrangement of the enamel is quite peculiar.

From the composition of the enamel, we must be aware of the bad effect of acidulated washes and powders to the teeth: they dissolve the surface, and give a deceitful whiteness to the teeth; they erode the surface, which it is not in the constitution of the part to restore.

OF THE CENTRAL BONY PART OF THE TOOTH.

The chemical composition, and the manner of combination of the matter forming the central part of the tooth, and of the fangs, is similar to other

bones of the body; but when we examine the hardness and the density of the tooth, and see that it is not even porous, or apparently capable of giving passage to vessels, we conclude that it is not vascular, and are apt to suppose that it holds its connection with the living jaw-bone by some other tenor than that of vessels, or the circulation of the blood through it. The body and fangs of a tooth are covered with a periosteum like other bones. The vascularity of the periosteum, which surrounds the tooth, and the vessels which enter by the fangs to the cavity of the tooth, seem to be a provision for supplying them plentifully with blood; but on further examination, it will prove to be a means only of fixing the tooth in the socket, and of preserving the sensibility of the nerve in the cavity of the tooth. As the bony part of the tooth has often been coloured by feeding young animals with madder, it might deceive some to suppose that there is blood circulating through the body of the tooth, and that the tooth undergoes the same changes by absorption which the other bones are proved to do. But these experiments may have been made while the teeth were forming by a secretion from the pulp, and of course they might be coloured, without the experiment affording a fair proof that the circulation continues in the tooth after it is formed.

OF THE VASCULARITY AND CONSTITUTION OF THE BONY PART OF THE TOOTH.

The teeth undergo changes of colour in the living body, to which it would appear they could not be liable as dead matter. They become yellow, transparent, and brittle with old age; and when a tooth has been knocked from its socket, and replaced, dentists have observed that it loses its whiteness, and assumes a darker hue.

The absorption of the roots in consequence of the caries of the body of the tooth, and the absorption of the fangs of the deciduous teeth, are further

alleged in proof of their vascularity; not only the pressure of the rising tooth on the fangs of the temporary teeth will cause an absorption of the latter, but the fangs of the temporary teeth will waste and be absorbed, so as to drop out without the mechanical pressure of the permanent teeth, and before they have advanced to be in contact with the former. Of what nature is this absorption of the fangs of the deciduous teeth? Is it an influence commencing in the tooth, or is it the agency of the vascular substance around the tooth?

The teeth seem acutely sensible; but a little consideration teaches us that the hard substance of the teeth is not endowed with sensibility, and that it must be the remains of the vascular pulp, presently to be described, occupying the centre of the tooth, which being supplied with nerves, gives the acute pain in tooth-ach. It is as a medium communicating or abstracting heat, that the condition of the tooth is attended with pain. When wrought upon by the dentist's file, no sensation is produced unless the tremor be communicated to the centre, or unless the abrading, or cutting instruments, be so plied as to heat the tooth; then an acute pain is produced from the heat communicated to the centre; and so ice or extremely cold liquids, taken into the mouth, produce pain, from the cold affecting the pulp through the body of the tooth.

As living parts, the teeth have adhesion to the periosteum, and are connected with their internal pulp; but when they spoil, and are eroded, the disease spreads inwardly, probably destroying the life of the bony part of the tooth, the progress of which disease is marked by a change of colour penetrating beyond the caries towards the centre of the tooth. When this discolouration has reached the internal surface, the pain of tooth-ach is excited; the pulp, vascular and supplied with nerves, inflames, from a want of accordance with the altered state of the tooth, just as the dead surface of a bone will inflame the central periosteum and marrow. The

extreme pain produced by this state of the tooth probably proceeds from the delicate and sensible pulp swelling in the confinement of the cavity of the tooth.

In caries of the teeth, the body of the tooth is discoloured deep in its substance long before the pulp of the central cavity is exposed by the progress of the caries. No exfoliation, or exostosis, takes place upon that part of the tooth which is above the gum, which, however, some say, may be owing to the mere compactness of the ossific depositions.

In the further consideration of this subject, there are circumstances which will make us conclude that there is no vascular action in the teeth, and incline us to believe that they possess a low degree of life, independent of vascular action. Supposing the bony part of the tooth to be vascular, and to possess the principle of life, is not the firm adhesion and contact of the enamel to the body of the tooth a curious instance of a part destitute of life adhering to the surface of a living part, without producing the common effects of excitement and exfoliation or inflammation in the latter.

In rickets, and mollities ossium, and other diseases of debility in which the body wastes, or the growth is retarded, the grown teeth are not altered in their form or properties. The effects which we perceive in the bony system, under these diseases, are produced by the activity of the absorbents prevailing over the action of the red vessels; while in the teeth no such effect can take place, if they are formed by a deposition of bony matter which is not re-absorbed, nor subject to the revolution of deposition and re-absorption, which takes place in other parts of the body. Accordingly we find in rickets, where the hardest bone yields, and where the jaw-bone itself is distorted or altered in its form by the actions of its muscles, that the teeth remain distinguished for their size and beauty. In mollities ossium I have found the teeth loose, but hard in their substance. In rickets the teeth are large, and perfectly

formed, while the jaws are stinted and interrupted in their growth. The consequence of this is, that the teeth form a larger range than the jaw, and give a characteristic protuberance to the mouth.

I must here observe, however, that if a child is in bad health during the formation of the teeth, they are often deficient in form, or the crust of enamel which covers them is irregular, and which circumstances continue through life; instances of this my reader may see in my Collection.

When an adult tooth of one jaw is lost, there appears to be a growth of the tooth of the opposite jaw; but I believe the tooth only projects from its socket a little further, in consequence of the want of that pressure to which it is naturally accommodated. The teeth of the *rodentia* are wasted by attrition, and seem to grow. This is, indeed, a growth, but it is of the nature of the first formation of the tooth proceeding from the pulp*; for while the tooth wastes by attrition on its anterior edge, it continues to grow by addition from the pulp, and to be pushed forwards.

Much has been said of balls being found in elephants' teeth, as they are found in bones, the bony matter accumulated around the ball, and considered to be a proof of the inflammation of the tooth, and of course of its vascularity. The specimens in the collections of Haller, Blumenbach, and Monro, are quoted. I possess a great variety of these specimens, of both iron and leaden balls immersed in the ivory of the elephant's tusk, but they prove that the pulp continuing to secrete bony matter, has enveloped the ball after it has pierced the shell of the tooth.

The roots of the teeth are sometimes found enlarged, distorted, or with exostosis formed upon them. Again, the cavity of the tooth is found filled up with what appears to be new matter, or around the fangs we often find a small sac of pus, which is drawn out in extracting the tooth. Nevertheless, in

* See the ingenious Inaugural Dissertation of Dr. Blake.

these examples of disease, there are no unequivocal marks of vascular action in the tooth; the unusual form, or exostosis of the roots, is produced by an original defect in the formation. The filling up of the cavity of the tooth is caused in the same way, or by the resumed ossific action of the pulp, in consequence of the disease and destruction of the body of the tooth; and the abscesses which surround the fangs are caused by the death of the tooth, in consequence of which it has lost its sympathy with the surrounding living parts, and becomes a source of irritation like a foreign body.

The transplanting of teeth presents another very interesting phenomenon. A tooth recently drawn, and placed accurately into a socket from which one has been taken, will adhere there: nay, it will even adhere to any living part, as in the comb of a cock. This, however, proves only that the tooth possesses vitality; for after it is taken from the natural socket, if it be kept any time it will not adhere; it has become a dead part, and the living substance refuses to unite with it. Again, and in opposition to this, is it not very extraordinary that a tooth may be burnt by chemical agents, or the actual cautery, down to the centre, and yet retain its hold; or that the body of the tooth may be cut off, and a new tooth fixed into it by a pivot? Had the teeth any vascular action, this torturing would cause reaction and disease in them. No doubt sometimes very distressing effects are produced by these operations, as tetanus, abscess in the jaws, &c.; but this happens in consequence of the central nerve being bruised by the wedging of the pivot in the cavity of the tooth, or by the roots of the tooth becoming, as dead bodies, a source of irritation to the surrounding sockets.

Of the gums. — The necks of the teeth are surrounded by the gums, a red, vascular, but firm substance, which covers the alveolar processes. To the bone and to the teeth the gums adhere very strongly, but the edge touching the tooth is loose. The gums have little sensibility in their healthy and sound state;

and by mastication, when the teeth are lost, they gain a degree of hardness which proves almost a substitute for the teeth. The use of the gum is chiefly to give firmness to the teeth, and at the same time, to give them that kind of support which breaks the jar of bony contact. Like the alveolar process, the gums have a secret connection with the state of the teeth. Before the milk-teeth appear, there is a firm ridge which runs along the gums, but this is thrown off, or wastes with the rising of the teeth: and as the teeth rise, the proper gums grow, and embrace them firmly. The gum is firm, and in close adhesion, when the teeth are healthy; loose, spongy, or shrunk, when they are diseased. The only means of operating upon the general state of the teeth is through the gums; and by keeping them in a state of healthy action, by the brush and tinctures, the dentist fixes the teeth, and preserves them healthy; but when they are allowed to be loose and spongy, and subject to frequent bleeding, (which is improperly called a scorbutic state,) the teeth become loose, and the gums too sensible. If a healthy tooth be implanted in the jaw, the gum grows up around it, and adheres to it; but if it be dead or diseased, the gum ulcerates, loosens, and shrinks from it; and this shrinking of the gums is soon followed by the absorption of the socket.

We must conclude, that the whole of the phenomena displayed in the formation, adhesion, and diseases of the teeth, show them to be possessed of life, and that they have a correspondence or sympathy with the surrounding parts. But are we prepared to acquiesce in the opinion of Mr. Hunter, that they possess vitality while yet they have no vascular action within them? We naturally say, how can such vitality exist independently of a circulation? In answer to this, there are not wanting examples of an obscure and low degree of life existing in animals, ova, or seeds, for seasons, without a circulation; and if for seasons, why not for a term of life? We never observe the animal economy providing superfluously;

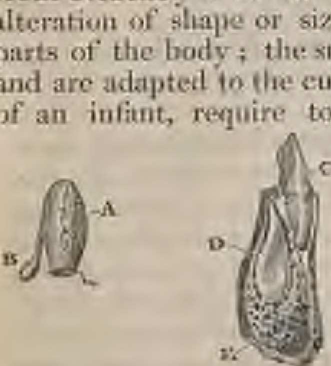
and since there is no instance to be observed in which the teeth have shown a power of renovation, why should they be possessed of vascularity and action to no useful purpose? All that seems necessary to them is, that they should firmly adhere without acting as a foreign and extraneous body to the surrounding parts; and this, vitality, without vascular action, seems calculated to provide.

OF THE FORMATION AND GROWTH OF THE TEETH.

In this figure we see the milk-teeth of one side of the lower jaw prepared to rise above the gum. They are in their distinct bony cells, and also surrounded with

their membraneous sacs. The first of the permanent teeth is also seen in a state of advancement.

In the jaws of a child newly born, there are contained two sets of teeth as it were in embryo; the deciduous, temporary, or milk-teeth; and the permanent teeth. The necessity for this double set of teeth evidently is to be found in the incapacity of alteration of shape or size in the teeth, as in other parts of the body; the smaller teeth, which rise first, and are adapted to the curve and size of the jaw-bone of an infant, require to be succeeded by others, larger, stronger, and carrying their roots deeper in the jaw.



Each tooth is formed in a little sac, which lies betwixt the plates of bone that form the jaw-bone of the fœtus, or child, under the vascular gum, and connected with it. A is the sac containing the milk-tooth: B the sac of the permanent tooth attached to the sac of the milk-tooth.

When we open one of these sacs at an early period of the formation of the tooth, a very curious appearance presents itself: a little shell of bone is seen within the sac, but no enamel is yet formed. Upon raising the shell of bone, which is of the shape of the tooth, and is the outer layer of the bony substance of the tooth, a soft vascular stool, or pulp*, is found to have been the mould on which this outer layer of ossific matter has been formed; and a farther observation will lead us to conclude, that this bony part of the tooth is in the progress of being formed by successive layers of matter thrown out from the surface of this vascular pulp; though many have explained the formation of the tooth, by supposing that the layers of this pulp were successively ossified. A is the pulp on which the tooth is formed: B the sac opened, which surrounds the pulp and new tooth, and which secretes the enamel: C the shell of the new tooth taken off the pulp A, to which of course it corresponds accurately in shape.

B

A

C

If we now turn our attention to the state of those teeth which we know to be later of rising above the gum, we shall find the ossification still less advanced, and a mere point, or perhaps several points of the deposited matter, on the top of the pulp.

The pulp, or vascular papilla on which the tooth is formed, has not only this peculiar property of ossification, or rather secretion of ossific matter, but, as the period of revolution advances, where it forms the rudiments of the molares for example, its base splits so as to form the mould of two, three, or four fangs, or roots; for around these divisions of the pulp the ossific matter is thrown out so as to form a tube, continued downwards from the body of the tooth. Gradually, and by successive layers of matter on the inside of this tube, it becomes a strong root,

* Le noyau, la coque, or le germe de la dent, by the French authors.

or fang, and the bony matter has so encroached on the cavity, that only a small canal remains, and the appearance of the pulp is quite altered, having shrunk into this narrow space.

We have said that the tooth forming on its pulp, or vascular bed, is surrounded with a membrane, giving the whole the appearance of a little sac. This membrane has also an important use. It is vascular also, as the pulp is, but it is more connected with the gums, and receives its vessels from the surface, while the pulp, lying under the shell of the tooth, receives its blood-vessels from that branch of the internal maxillary artery which takes its course in the jaw.

The enamel is formed after the body of the tooth has considerably advanced towards its perfect form. It is formed by a secretion from the capsule, or membrane, which invests the teeth*, and which is originally continuous with the lower part of the pulp. The enamel is thicker at the point, and on the body of the tooth, than at its neck. Mr. Hunter supposed that the capsule always secreting, and the upper part of the tooth being formed first, it would follow, of course, that the point and body of the tooth would be covered with a thicker deposition; but it rather appears that that part of the sac opposite to the upper part, and body of the tooth, has a greater power of secreting, being in truth more vascular and spongy; for the whole of the body of the bony part of the tooth is formed before the enamel invests the tooth.

We are indebted to M. Herissant for much of the explanation of the manner in which the enamel is formed. He describes the sac; its attachment to the pulp and to the neck of the teeth. As the tooth advances to its perfect form, the sac also changes. At first it is delicate and thin, but it thickens apace. And he asserts, that if after this progress is begun you examine the inner surface of it with a glass, you

* This outer sac has been called *chorion*, from the numerous vessels distributed upon it.

will perceive it to be composed of little vesicles in regular order, and which sometimes have a limpid fluid contained in them. This liquid exuded upon the surface of the teeth he supposes to form the enamel. He explains also how this sac, originally investing the body and neck of the tooth, being pierced by the edge of the tooth, and the tooth rising through it, is inverted, and by still keeping its connection with the circle of the crown of the tooth, rises up in connection with the gum, and in some degree forms the new gum which surrounds the tooth.

The sac which encloses the rudiments of the tooth consists of a double membrane. The outer membrane is of a looser texture, and vascular; the inner is vascular also, but delicate and soft. Mr. Hunter said, that while the tooth is within the gum, there is always a mucilaginous fluid, like the synovia in the joints, between this membrane and the pulp of the tooth. I do not imagine that the enamel is produced by the concretion of this humour, which we may find at any period of the growth of the body of the tooth; but that the secreting surface changes the nature of its action, when the bone of the tooth is perfected in its outer layer, and that it then throws out the matter which consolidates into enamel.

This subject of the formation of teeth would be incomplete if we left unexplained the peculiar structure of the teeth of graminivorous animals.

Mr. Corse, in a curious paper in the Philosophical Transactions of London for the year 1799, describes the grinding tooth of an *elephant* in the following terms: — In describing the structure of the grinders, it must be observed, that a grinder is composed of several distinct laminæ or teeth, each covered with its proper enamel; and that these teeth are merely joined to each other by an intermediate softer substance, acting like cement.

The structure of the grinders, even from the first glance, must appear very curious, being composed

of a number of perpendicular laminæ, which may be considered as so many teeth, each covered with a strong enamel, and joined to one another by the common osseous matter. This being much softer than the enamel, wears away faster, by the mastication of the food; and, in a few months after some of these teeth cut the gum, the enamel remains considerably higher, so that the surface of each grinder soon acquires a ribbed appearance, as if originally formed with ridges.

The pulp of graminivorous animals is not shaped like that which forms the human tooth; it consists of several processes united at their base. The capsule has also processes which hang into the interstices of the pulp; the pulp forms a shell of bone which in time covers it. The processes of the capsule, which of course hang into the interstices of this layer of bone, (which has taken the exact form of the pulp,) form over the bone layers of enamel. The tooth now consists of conical processes of bone, united at their roots, and the surfaces of these processes have deposited on them the enamel. The membraneous productions of the capsule having completed the enamel, change the nature of their secretion somewhat, and throw out a bony matter, which Dr. Blake has called the *crusta petrosa*. By the formation of this last matter of the tooth, the processes which secrete are encroached upon so much, that they shrink altogether, and into the place left by them, after they have lost their power of secreting, foreign matter is sometimes introduced by mastication.*

The effect of this formation is to make the layers of the enamel pervade the whole substance of the tooth, the better to make it stand against the continued attrition necessary in the grinding and rumination of the herbivorous and graminivorous animals. The grinding teeth of the purely carnivorous animals,

* See a paper of Sir E. Home's in the Philosophical Transactions, and Dr. Blake's Inaugural Dissertation.

as of the lion and tiger, close like the blades of scissars: they are prevented by the long canine teeth from moving laterally; and as they are not subject to attrition, the enamel only covers their surfaces.

OF THE GROWTH OF THE SECOND SET OF TEETH, AND THE SHEDDING OF THE FIRST.

The teeth of the first or deciduous set are twenty in number. They are small, being adapted for the jaws of a child; they are destined to be shed, and to give place to the adult or permanent set of teeth. Accordingly, in observing the progress of the formation of this first set of teeth, the rudiments of the second may also be seen so early as in the fœtus of the seventh or eighth month; and in the fifth and sixth month after birth, the ossification begins in them. The rudiment of the permanent tooth may be observed even when the sac which contains it is very small, and appears like a filament stretching up to the neck of the sac of the deciduous tooth.* These sacs lie on the inner side of the jaw-bone, and when further advanced, the necks of the two sacs (both as yet under the gum) are united; but when the first teeth are fully formed, and have risen above the gum, the alveolar processes have been at the same time formed around them, and now the sacs of the permanent teeth have a connection with the gums through a small foramen in the jaw-bone, behind the space through which the first teeth have risen.

The opinion entertained, that the second set of teeth push out the first, is erroneous, for the change on the deciduous and the growing teeth seems to be influenced by laws of coincidence, indeed, but not of mechanical action. Sometimes we observe the falling tooth wasted at the root, or on the side of the fang, by the pressure of the rising tooth. Now here we should suppose that the newly formed tooth should

* See the two figures in page 241.

be the most apt to be absorbed by the pressure of the root of the deciduous tooth, did we not recollect that the new tooth is invested with the hard enamel, while the pressure on the other is upon the bony root. But there is more than this necessary to the explanation of the shedding of the teeth, for often the fang is wasted, and the tooth adheres only by the gum, and the permanent tooth has made little progress in its elevation, and has not pressed upon it.

This decay and wasting of the fangs of the teeth looks more like a satisfactory proof of their vascularity, than any other change to which they are subject. Yet there seems to be no reason why we should not suppose, that as the rudiments of the teeth rise into action at a particular time, and form the bony centre of the tooth, the decomposition should be effected by similar laws; that at a particular period the tooth should decay, and that the decay of the tooth should begin with the destruction of the fangs. Has the bony part of the tooth a tendency to dissolution independently of a circulation of blood through it? and as the roots waste, do the surrounding vascular parts absorb its substance? or, does the surrounding vascular substance operate on the tooth dissolving, and absorbing it, as it is said a dead bone is absorbed, when placed upon an ulcer?

When the internal vascular substance of a tooth is destroyed, it does not waste: when teeth are pivoted, their roots remain twenty years without wasting or being absorbed; and when the vascular centre of the milk-teeth is destroyed, their roots waste no more, and they continue adhering to the gum. This seems to point to the internal membrane of the tooth as the means of its absorption.

It is no proof of the first set being pushed out by the second set of teeth, that if the permanent teeth do not rise, the first will remain, their roots unwasted and firm, even to old age; for still I contend, that there is an agreement and coincidence betwixt the

two sets of teeth in their changes, and also in the alveoli by which they are surrounded; but this is not produced by the pressure of the rising teeth. When a dentist sees a tooth seated out of the proper line, and draws it, and finds that he has made the mistake of extracting the adult tooth, letting the milk-tooth remain, he must not expect that the milk-tooth will keep its place, for the contrary will happen; it will in general fall out.

The old and the new teeth are lodged in distinct compartments of the jaw-bone, and, what is more curious, their alveoli are distinct; for as the roots of the first teeth decay, their alveolar processes are absorbed, while again, as the new teeth rise from their deep seat in the jaw-bone, they are accompanied with new alveoli; and the chief art of the dentist in shifting the seat of the teeth, is gradually to push them along the jaw, notwithstanding the bony partitions or alveoli and processes, so as to bring them into equal and seemly lines. It is curious to observe, that the alveoli will, by the falling out of one tooth, or the operation of wedging betwixt the teeth, change their place in the jaw.

When a tooth is lost, it appears as if the space it occupied were partly filled up by an increased thickness of the adjacent teeth, and partly by the lengthening of that which is opposite: indeed, this appearance has been brought as a proof of the continual growth of teeth. But there is a fallacy in the observation; for when the space appears to have become narrow by the approximation of the two adjacent teeth, it is not owing to any increase of their breadth, but to their moving from that side where they are well supported to the other side where they are not. For this reason they get an inclined direction; and this inclination may be observed in several of the adjoining teeth.

No circumstance can better illustrate how perfect the dependence of the alveoli is upon the teeth, than that of their being thrown off with them in extensive exfoliations. I have a specimen of this in my Col-

lection, where the whole circle of the alveolar processes and teeth is thrown off. This happened after the confluent small-pox. I think I recollect a similar case occurring to Dr. Blake. In those tumours which arise from the alveoli and gums, filling the mouth with a cancerous mass, and softening the upper part of the jaw, there is no eradicating the disease but by taking away the whole adventitious part of the jaw which belongs to the teeth, and leaving only the firmer base. But even this operation will be too often unsuccessful.

OF THE MUSCLES.

THEIR TEXTURE, AND THE VARIETIES IN THE ARRANGEMENT OF THEIR FIBRES.

THE muscles are the appropriate organs of motion. They are distinguished by their peculiar texture, and by their singular vital property of contraction.*

The muscle is the only proper fibrous texture in the human frame. These fibres have the power of contracting, and are the active agents, in contradistinction to the bones and tendons, and ligaments, which are passive instruments under the influence of the muscles. The muscular fibres are formed into packets, or fasciculi: these fasciculi are variously ordered or arranged in the several muscles, and adapted to the action to be performed.

The proper muscular fibres are everywhere enveloped by the common cellular substance. Towards the extremities of the muscle, the proper fibres become fewer, and begin successively to terminate; by which the cellular membrane, being free from the interposition of the fibres, the divisions of it approach, and become more firmly combined, so as to form a tendon or rope. This tendon holds relation to each fibre of the proper muscle; and when these fibres contract, they concentrate and unite their power upon the tendon. The tendons, then, are not the continuations of the fibres of the proper muscle, but of the interstitial cellular membrane.

* At the end of the history of the muscles, the subject of *muscular power* is treated of.

Every muscle is supplied with arteries, veins, lymphatics, and nerves. Without nerves they would be insulated parts, contracting perhaps spasmodically and irregularly; but through the nerves these contractions are regulated so as to be efficient in the economy of the system, or the motions of the body.

The muscles are divided into simple and compound; the simple muscles are those which have their fibres in a similar direction and disposition. The most common being the *ventriform*, so called because the middle is large, and they diminish gradually towards their tendons or extremities.

I have given here the example of the ventriform muscle in the biceps, which, as it has two heads or tendinous origins running into one belly, is so named. Another simple muscle is when the fibres are laid flat and *parallel*: these do not terminate in a round tendon, but in a broad web of the same material. The muscles are *radiated*; that is, their fibres are laid diverging, or like the radii of a circle.

This is the pectoralis major, which is an example of the fibres converging to their tendinous insertion. Or they are *penniform*; that is, resembling the feathers of a quill, the fibres running parallel, but all of them oblique to their tendons. There is a *double penniform* muscle, which, indeed, is the form most like a quill or feather; for a double range of parallel fibres are obliquely inserted or attached to the tendon, the tendon running up

betwixt them. There are muscles which are called *complicated*, from their having two or more tendons, and a variety in the insertion of oblique fibres into these tendons. From the different disposition of the fibres results the absolute force of the muscles; but the mode of the attachment, or, as it is termed, the insertion of their tendons, determines their real effect.

The muscles accomplish very different purposes. Their first, or most important purpose, is to move the fluids through the intestines and hollow tubes, thus performing the motions necessary to the vital functions.* Besides these, they conform themselves, commonly, to the apparatus of the frame. 1. They envelope and compress, and sustain the viscera, as the abdominal muscles. 2. They lengthen, shorten, or compress some organ, as the tongue. 3. They widen or contract some aperture, as the sphincter muscles. 4. They relax, or draw up, or render rigid some valve, or septum, or curtain, as the velum of the palate. 5. They roll or move, and are thus subservient to the organs of the senses, as the eye and ear. 6. They are inserted or attached to the bones, and thus perform the voluntary motions. It is principally in this last office that we have now to study them. The human body is estimated to have 436 muscles, differing, however, in the sexes, and according to individual peculiarities. In these examples, with little exception, the fibres run obliquely to their insertions; by which they lose force, but gain velocity, in the motion communicated to their point of insertion.

A muscle is fibrous, that is, it consists of minute threads bundled together, the extremities of which are connected with the tendons which have been described. Innumerable fibres are thus joined together to form one muscle, and every muscle is a distinct organ. Of these distinct muscles for the motions of

* They embrace and contract on the hollow viscera, as the bladder and uterus.

the body there are not less than 436 in the human frame, independent of those which perform the internal vital motions. The contractile power, which is in the living muscular fibre, presents appearances which, though familiar, are really the most surprising of all the properties of life. Many attempts have been made to explain this property, sometimes by chemical experiment, sometimes on mechanical principles, but always in a manner repugnant to common sense. We must be satisfied with saying, that it is an endowment, the cause of which it would be as vain to investigate as to resume the search into the cause of gravitation.

The ignorance of the cause of muscular contraction does not prevent us from studying the laws which regulate it, and under this head are included subjects of the highest interest; which, however, we must leave, to pursue the mechanical arrangement of the muscles.

Since we have seen that there are so many muscles in the body, it is due to our readers to explain how they are associated to effect that combination which is necessary to the motion of the limbs and to our perfect enjoyment. In the first place, the million of fibres, which constitute a single muscle, are connected by a tissue of nerves, which produce a union or sympathy amongst them, so that one impulse causes a simultaneous effort of all the fibres attached to the same tendon. When we have understood that the muscles are distinct organs of motion, we perceive that they must be classed and associated, in order that many shall combine in one act; and that others, their opponents, shall be put in a state to relax, and offer no opposition to those which are active. These relations can only be established through *nerves*, which are the organs of communication with the brain, or sensorium. The nerves convey the will to the muscles, and at the same time they class and arrange them so as to make them consent to the motions of the body and limbs.

On looking to the manner in which the muscles are fixed into the bones, and the course of their tendons, we observe everywhere the appearance of a sacrifice of mechanical power, the tendon being inserted into the bone in such a manner as to lose the advantage of the lever. This appears to be an imperfection, until we learn that there is an accumulation of vital power in the muscle in order to attain velocity of movement in the member.

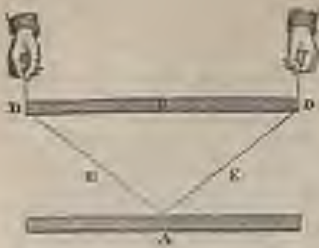
The muscle D, which bends the fore-arm, is inserted into the radius E, so near the fulcrum, or centre of motion in the elbow joint, and so obliquely, that it must raise the hand and fore-arm with disadvantage. But, correctly speaking, the power of the muscle is not sacrificed, since it gains more than an equivalent in the rapid and lively motions of the hand and fingers, and since these rapid motions are necessary to us in a thousand familiar actions; and to attain this, the Creator has given sufficient vital power to the muscles to admit of the sacrifice of the mechanical or lever power, and so to provide for every degree and variety of motion which may answer to the capacities of the mind.

If we represent the bones and muscles of the fore-arm by this diagram, we shall see that power is lost by the inclination of the tendon to the lever, into which it is inserted. It represents the lever of the third kind, where the moving power operates on a point nearer the fulcrum than the weight to be moved.

Here A represents the muscle, B the lever, and C the fulcrum. The power of the muscle is not represented by the distance of its insertion *a*, from the fulcrum C. The line which truly represents the lever must pass from the centre of motion, perpendicularly to the line of the tendon, *viz.*, C *b*. Here, again, by the direction of the tendon, as well as by its actual attachment to the bone, power is lost and velocity gained.

We may compare the muscular power to the weight which impels a machine. In studying machinery, it is manifest that weight and velocity are equivalent. The handle of the winch in a crane is a lever, and the space through which it moves, in comparison with the slow motion of the weight, is the measure of its power. If the weight, raised by the crane, be permitted to go down, the wheels revolve, and the handle moves with the velocity of a cannon-ball, and will be as destructive if it hit the workman. The weight here is the power, but it operates with so much disadvantage, that the hand upon the handle of the winch can stop it: but give it way, let the accelerated motion take place, and the hand would be shattered which touched it. Just so the fly-wheel, moving at first slowly, and an impediment to the working of a machine, at length acquires momentum, so as to concentrate the power of the machine, and enable it to cut bars of iron with a stroke.

The principle holds in the animal machinery. The elbow is bent with a certain loss of mechanical power; but by that very means, when the loss is supplied by the living muscular power, the hand descends through a greater space, moves quicker, with a velocity which enables us to strike or to cut. Without this acquired velocity, we could not drive a nail: the mere muscular power would be insufficient for many actions quite necessary to our existence.



Let us take some examples to show what objects are attained through the oblique direction of the fibres of the muscle, and we shall see that here, as well as by the mode of attachment of the entire muscle, velocity is attained by the sacrifice of power. Suppose these two pieces of wood are to be drawn together by means of a cord, but that the hands which pull, although possessing abundant strength, want room to recede more than what is equal to one third of the space betwixt the pieces of wood; it is quite clear, that if the hand were to draw directly on a cord between A and B, the point A would be brought towards B, through one third only of the intervening space, and the end would not be accomplished. But if the cord were put over the ends of the upper piece, as E D, and, consequently, directed obliquely to their attachment at A, on drawing the hand back a very little, but with more force, the lower piece of wood would be suddenly drawn up to the higher piece, and the object attained. Or we may put it in this form: — If a muscle contract in the direction of its tendon, the motion of the extremity of the tendon will be the same with that of the muscle itself: but if the attachment of the muscle to the tendon be oblique, it will draw the tendon through a greater space; and if the direction of the muscle deviate so far from the line of the tendon as to be perpendicular to it, it will then be in a condition to draw the tendon through the greatest space with the least contraction of its own length.

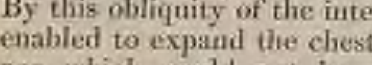
Thus, if A B be a tendon, and C D a muscle; by the contraction of C to D the extremities of the tendon A B will be brought together, through a space double the contraction of the muscle. It is the adjustment, on the same principle,

which gives the arrow so quick an impulse from the spring of the bow, the extremities of the bow drawing obliquely on the string.

To free breathing, it is necessary that the ribs shall approach each other, and this is performed by certain *intercostal* muscles, (or muscles playing between the ribs;) and now we can answer the question, why are the fibres of these muscles oblique?

Let us suppose this figure to represent two ribs with thin intervening muscles. If the fibres of the muscle were in the direction A, across and perpendicular to the ribs; and if they were to contract one third of their length, they would not close the intervening space — they would not accomplish the purpose. But being oblique, as at B, although they contract no more than one third of their length, they will bring the ribs C D together. By this obliquity of the intercostal muscles, they are enabled to expand the chest in inspiration, in a manner which could not be otherwise accomplished. However, let the reader understand that, in respect to the motions of respiration, we are stating the action of these fibres in the simplest mode. Had we to explain here the expansion of the ribs in inspiration, it would be necessary to consider the attachments of the ribs as counteracting forces.

In the greater number of muscles the same principle directs the arrangement of the fibres; they exchange power for velocity of movement, by their obliquity. They do not go direct from origin to insertion, but obliquely, thus, from tendon to tendon:—



Supposing the point A to be the fixed point, these fibres draw the point B with less force, but through a larger space, or more quickly than if they took their course in direct lines; and by this arrangement of the fibres the freedom and extent of motion in our limbs are secured.

But the muscles must be strengthened by additional courses of fibres, because they are oblique; since by their obliquity they lose somewhat of their force of action: and therefore it is, we must presume, that we find them in a double row, making what is termed the *penniform* muscle, thus, —

and sometimes the texture of the muscle is still further compounded by the intermixture of tendons, which permit additional series of fibres; and all this for the obvious purpose of accumulating power, which may be exchanged for velocity of movement.

We may perceive the same effect to result from the course of the tendons, and their confinement in sheaths, strengthened by cross-straps of ligament. If the tendon A took the shortest course to its termination at B, it would draw up the toe with

greater force; but then the toe would lose its velocity of movement. By taking the direction C close to the joints, the velocity of motion is secured, and by this arrangement the toes possess their spring, and the fingers their lively movements.

We may take this opportunity of noticing how the mechanical opposition is diminished as the living muscular power is exhausted. For example, in lifting a weight, the length of the lever of resistance will be from the centre of the elbow joint, A, to the centre

of the weight, B. As the muscles of the arm contract, they lose something of their power; but in a greater proportion is the mechanical resistance diminished, for when the weight is raised to C, then A D becomes the measure of the lever of resistance.

A more admirable thing is witnessed by the anatomist — we mean the manner in which the lever, rising or falling, is carried beyond the sphere of action of one class of muscles, and enters the sphere of activity of others. And this adaptation of the organs of motion is finely adjusted to the mechanical resistance which may arise from the form or motion of the bones. In short, whether we contemplate the million of fibres which constitute one muscle, or the many muscles which combine to the movement of the limb, nothing is more surprising and admirable than the adjustment of their power so as to balance mechanical resistance, arising from the change of position of the levers.

In the animal body, there is a perfect relation preserved betwixt the parts of the same organ. The muscular fibres forming what is termed the belly of the muscle, and the tendon through which the muscle pulls, are two parts of one organ; and the condition of the tendon indicates the state of the muscle.

Thus jockies discover the qualities of a horse by its sinews or tendons. The most approved form in the leg of the hunter, or hackney, is that in which three convexities can be distinguished, — the bone; the prominence of the elastic ligament behind the bone; and behind that the flexor tendons, large, round, and strong. Strong tendons are provided for strong muscles, and the size of these indicate the muscular strength. Such muscles, being powerful flexors, cause high and round action, and such horses are safe to ride; their feet are generally preserved good, owing to the pressure they sustain from their high action. But this excellence in a horse will not make him a favourite at Newmarket. The circular motion cannot be the swiftest; a blood-horse carries his foot near the ground. The speed of a horse depends on the strength of his loins and hind quarter; and what is required in the fore-legs is strength of the extensor tendons, so that the feet may be well thrown out before, for if these tendons be not strong, the joints will be unable to sustain the weight of his body, when powerfully thrown forward, by the exertion of his hind-quarters, and he will be apt to come with his nose to the ground.

The whole apparatus of bones and joints being thus originally constituted by Nature in accurate relation to the muscular powers, we have next to observe, that this apparatus is preserved perfect by exercise. The tendons, the sheaths in which they run, the cross ligaments by which they are restrained, and the *bursæ mucosæ* *, which are interposed to diminish friction, can be seen in perfection only when the animal machinery has been kept in full activity. In inflammation, and pain, and necessary restraint, they become weak; and even confinement, and want of exercise, without disease, will produce imperfections. Exercise unfolds the muscular system, producing a full bold outline of the limbs, at the same

* These *bursæ mucosæ* (mucous purses) are sacs containing a lubricating fluid. They are interposed wherever there is much pressure or friction, and answer all the purposes of friction-wheels in machinery.

time that the joints are knit, small, and clean. In the loins, thighs, and legs of a dancer we see the muscular system fully developed; and when we turn our attention to his puny and disproportioned arms, we acknowledge the cause — that, in the one instance, exercise has produced perfection, and that, in the other, the want of it has occasioned deformity. Look to the legs of a poor Irishman travelling to the harvest with bare feet: the thickness and roundness of the calf show that the foot and toes are free to permit the exercise of the muscles of the leg. Look, again, to the leg of our English peasant, whose foot and ankle are tightly laced in a shoe with a wooden sole, and you will perceive, from the manner in which he lifts his legs, that the play of the ankle, foot, and toes is lost, as much as if he went on stilts, and, therefore, are his legs small and shapeless.

For the purpose of dissection, it is as necessary to understand the varieties in the forms of the tendons as of the muscles. The tendons are textures of great strength and firmness, which are intermediate betwixt the irritable fibres, forming a muscle, and the points of attachment. The ligaments are of the same texture, but they want this part of the definition; they are stretched from one fixed point to another, not intermediate betwixt muscular fibres and bone.

Very often the TENDON of a muscle assumes a round form, and resembles a rope; but they are also of a flat form, or extended into a web, or they are radiated, and spreading in digitations. It is difficult actually to distinguish the expanded tendons from the FASCIÆ and APONEUROSES, which are sheets of a tendinous intertexture, to which very often muscles are attached, but which have other offices, besides affording attachment of muscles.

The FASCIÆ cover and embrace the limbs like bandages. Their under surfaces have, generally, divisions and subdivisions, which sink down betwixt the muscles, and serve to class them, and sometimes to direct their action, and to hold them as in a sheath. The APONEUROSIS is a term somewhat loosely

applied: we shall consider it as expressive of those sheets of tendinous texture, which are continued from the tendons or ligaments, without fairly embracing the limb. They differ in density and firmness from the shining, silvery, expanded tendon, to the layer of the common, soft, cellular texture.

Another variety of the tendon, or ligament, is the ring of firm ligamentous substance, which is in the neighbourhood of the joints, and which ties down the tendons, which would otherwise start from their places: and which, furnishing sheaths to the tendons, directs their course, and, as it were, appropriates the action of the muscle.

See further of these subjects under the title of THE CELLULAR SUBSTANCE.

OF THE MUSCLES OF THE FACE, EYE, AND EAR.

MUSCLES OF THE FACE.

Occipito-Frontalis.

I. The OCCIPITO-FRONTALIS is a broad and thin muscular expansion, which covers all the upper part of the cranium. It consists of two bellies, with an intermediate sheet of flat tendon. The one belly covers the occiput, the other covers the forehead, and the tendinous expansion covers all the upper part of the head; by which it has happened that the most eminent anatomists, as Cowper, (p. 29.) have misnamed its tendon, pericranium; many have reckoned it two distinct muscles, viz. the OCCIPITAL and FRONTAL, while others (because of a sort of rapha, or line of division in the middle of each belly,) have described four muscles, viz. two frontal, and two occipital muscles. But it is truly a double-bellied muscle; and the broad thin tendon, which belongs equally to both bellies, lies above the true pericranium, and slides upon it. The muscle is therefore named, with strict propriety, occipito-frontalis, sometimes EPICRANIUS, sometimes BIVENTER, or DIGASTRICUS CAPITIS.

ORIGIN. — The occipital portion is the fixed point of this muscle, arising from the superior transverse ridge of the occipital bone, and covering the back part of the head, from the mastoid process of one side, round to that on the opposite side of the head. And by the perpendicular ridge of the occiput, it is marked with a slight division in the middle.

Or. sup. transverse ridge of the occipital bone, and from back part of the mastoid pro. of temporal bone.

INSERTION. — The fore belly of the muscle which covers the forehead is fixed more into the skin and eye-brows than into the bone: it is slightly attached to the bone, near the inner end of the orbitary ridge, and especially about the inner corner of the eye, and the root of the nose, by a smaller and acute pointed process called the descending slip of the occipito-frontalis; but still its chief attachment is to the skin under the eye-brows.

1. *In. orbicularis palpebræ*, skin of the eye-brow. 2. Superciliary ridge; 3. by a distinct slip to the intern. ang. process.

The TENDON or thin MEMBRANEOUS expansion which joins the two bellies is exceedingly thin: it has on its inner side much loose cellular substance, by which, though attached to the true pericranium, it slides easily and smoothly upon it; but its outer surface is so firmly attached to the skin, and its fore belly adheres so firmly to the eye-brows, that it is very difficult to dissect it clean and fair.

I consider the occipital belly as the fixed point, having a firm origin from the ridge of the bone; its frontal belly has the loose end attached, not to the os frontis, but to the eye-brow and skin, and its office, that of raising the eye-brows, wrinkling the forehead, and corrugating the whole of the hairy scalp. It is a muscle expressive of passion, and it is sometimes so thin as hardly to be perceived.

There is a small, neat, and pointed slip of the occipito-frontalis, which goes down with a peak towards the nose, and is inserted into the small nasal bone. This process being much below the end of the eye-brow, must pull it downwards; so that while the great muscle raises the eye-brow and skin of the forehead, this small nasal slip pulls the eye-brow downwards again, restoring it to its place, and smoothing the skin.

Descending slip.

II. The CORRUGATOR SUPERCILII is a small muscle which lies along the upper margin of the orbit, under the last. Its origin is from the internal angular process of the frontal bone. Thence it runs outward, and a little upward, to be inserted into the skin under the eye-brow. Its action is to knit and corrugate the eye-brows.

Or. intern. angular process. *In.* skin of the eye-brow.

III. ORBICULARIS PALPEBRARUM is a neat and regular muscle, surrounding the eye, and covering the eye-lids in a circular form. It should be considered as two muscles, for there are a set of pale fibres running on the eye-lids, which move in the rapid and involuntary motion of the eye-lids. There are other stronger and redder fibres, which run round the orbit, and these are only used in passion, or in spasmodic closing of the eye-lids, as when something irritates the organ, and forces out the tears. It has one small tendon in the inner corner of the eye, which is both its origin and insertion; for it begins and ends in it. This small tendon is easily felt through the skin in the inner corner of the eye. It arises by a little white knot from the nasal process of the upper jaw-bone. Its fibres immediately become muscular, and spread out thin over the upper eye-lid. They pass over it to the outer corner of the eye, where they cross a little, and having covered just the edge of the temple with their thin expanded fibres, they return in a circular form round by the lower eye-lid to the point from whence they had set out. It is rather a little broader over the lower eye-lid, extends itself a little upon the face beyond the brim of the socket, both at the temple and upon the cheek; and its fibres cross each other a little at the outer angle; so that some understanding this crossing as a meeting of fibres from the upper and from the lower muscle, have described it as two semicircular muscles. And those fibres which are next to the tarsus or cartilaginous circle of the eye-lids, were distinguished by Riolan, under the title of MUSCULUS CILIARIS. Our name expresses the common opinion, that it is a circular

Orbicularis oculi.

Or. orbitary pro. of the sup. maxillary bone.

In. the same.

Musculus ciliaris.

muscle, whose chief point or fulcrum is in the inner corner of the eye, and which serves as a sphincter for closing the eye. It squeezes with spasmodic violence, when the eye is injured, as by dust. And by its drawing down the eye-lids so firmly, it presses up the ball of the eye hard into the socket, and forces the lachrymal gland that is within the socket, so as to procure a flow of tears.

Levator palpebræ superioris.

IV. Levator palpebræ superioris.—This small muscle arises deep within the socket, from the margin of that hole which gives passage to the optic nerve. It begins by a small flat tendon in the bottom of the optic cavity, becomes gradually broader as it goes over the eye-ball; it ends in the eye-lid, by a broad expansion of muscular fibres, which finally terminate in a short flat tendon. It lies under the orbicularis palpebræ, is inserted into the whole length of the cartilage of the tarsus, and raises and opens the upper eye-lid.

Or. upper part of margin of foramen opticum.

In. whole length of superior ciliary cartilage.

Action of these muscles.

The occipito-frontalis, but especially its occipital belly, raises the eye-brows; the pointed slip of the same muscle pulls them downwards; the corrugator pulls them directly inwards, and knits the brows: the levator palpebræ opens the eye-lid, and the orbicularis oculi closes the eye. Whether certain fibres from the platysma-myoides (a thin flat muscle which mounts from the neck over the cheek) may not pull down the lower eye-lid, or whether some straggling fibres, arising from the zygoma, may not have the appearance of a depressor of the lower eye-lid, it is not necessary to determine, since there is no regularly-appointed muscle, and the lower eye-lid is not directly moved, at least in man.*

MUSCLES OF THE NOSE AND MOUTH.

Levator labii superioris alæque nasi.

V. Levator labii superioris and alæ nasi.—Cowper describes the levator labii superioris as an irregular production of the frontalis, extending along the nostrils. But it is a neat and delicate muscle, which arises, by a small double tendon, from the

* See of the motions of the eye, vol. iii.

Or. Nasal pro. of sup. max. bone.

nasal process of the upper jaw-bone, close by the tendon of the orbicularis oculi. It is one little fasciculus of muscular fibres above; but as it approaches the nose, it spreads out broader, dividing into two small fasciculi, one of which is implanted into the wing or cartilage of the nose, and the other, passing the angle of the nose, goes to the upper lip: thus it is pyramidal with its base downwards, and was named pyramidalis by Casserius, Winslow, and others. It is called by Cowper dilator alæ nasi; it raises the upper lip, and spreads the nostrils wide, as is observed in a paroxysm of rage, or in asthmatics.

In. upper lip and ala nasi.

Levator labii superioris proprius.

VI. The LEVATOR LABII SUPERIORIS PROPRIUS is distinguished by the name of levator proprius, because there are two others; one belonging to the angle of the mouth, and consequently to both lips; and one common to the lip and nostril.

Or. Orbit. pro. of sup. max. b. below the infra orbit. foramen.

In. upper lip and orbicularis muscle.

The levator proprius is often named musculus incisivus, because it arises from the upper jaw, just above the incisores, or cutting teeth, and consequently just under the edge of the orbit; it is broad at its origin; it lies flat and runs downwards, and obliquely inwards, to the middle of the lip, till it meets its fellow just in the filtrum.* It pulls the upper lip and the septum of the nose directly upwards. It generally receives a slip from the orbicularis oculi.

Levator anguli oris.

VII. The LEVATOR ANGULI ORIS is called also LEVATOR COMMUNIS LABIORUM, because it operates equally on both lips. It is named CANINUS; for as the last-named muscle rises from the upper jaw-bone above the incisores or cutting teeth, this arises above the canini or dog-teeth, or above the first grinder, by a very short double tendon. The exact place of its origin is half way betwixt the first grinder and the infra orbitary hole: it is mixed with the orbicularis oris, at the corner of the mouth, so that it raises the angle of the mouth upwards.

Or. super. maxillary b. between the first molaris and the inf. orb. for.

In. angle of the mouth.

Zygomaticus major.

Or. on malæ near the zygomatic suture.

VIII. The ZYGOMATICUS MAJOR arises from the cheek-bone near the zygomatic suture; it runs downwards and inwards to the corner of the mouth; is a

* The filtrum is the superficial gutter along the upper lip from the partition of the nose to the tip of the lip.

long and slender muscle, which ends by mixing its fibres with the orbicularis oris and the depressor of the lip.

In. angle of the mouth.

IX. The ZYGOMATICUS MINOR arises a little higher upon the cheek-bone, but nearer the nose; it is much slenderer than the last, and is often wanting. In negroes we frequently find three zygomatic muscles.

Zygomaticus minor. Or. os malæ higher and nearer the nose than the last. In. the lip between the lev. prop. & zygo major.

It is the zygomatic muscle that marks the face with that line which extends from the cheek-bone to the corner of the mouth, and which is so strong in many. The zygomatic muscles pull the angles of the mouth upwards as in laughter; or one of them distorts the mouth, whence the zygomatic muscle has got the name of distortor oris: the strong action of the muscle is particularly seen in laughter, rage, grinning.

Buccinator.

X. BUCCINATOR.—The buccinator was long thought to be a muscle of the lower jaw, arising from the upper alveoli, and inserted into the lower alveoli to pull the jaw upwards; but its origin and insertion, and the direction of its fibres, are quite the reverse of this. For this large flat muscle, which forms, in a manner, the walls of the cheek, arises chiefly from the coronoid process of the lower jaw-bone, and partly also from the end of the alveoli or socket process of the upper-jaw, close by the pterygoid process of the sphenoid bone; it arises also from the upper jaw; it goes forwards with direct fibres to be implanted into the corner of the mouth, within the orbicularis. It is thin and flat, and forms the walls of the cheek; it is perforated in the middle of the cheek by the duct of the parotid gland. Albinus describes two irregular sets of fibres, besides mentioning those which are running directly to the angle of the mouth: 1. One narrow slip which runs in a semicircular direction, and joins the inner surface of the upper lip; 2. Another considerable slip which runs much in the direction of the orbicularis towards the middle of the lip; this he calls the appendix of the buccinator. These are its principal uses: that it flattens the cheek, and so assists in swallowing liquids; that it turns, or helps to

Or. 1. alveolar pro. of lower jaw. 2. the coronoid pro. 3. the space between the last molaris of upper jaw and pterygoid pro. of sphenoid bone. 4. the point of the ptery. pro. In. into the angle of the mouth.

Use.

turn, the morsel in the mouth while chewing, and prevents its getting without the line of the teeth: in blowing wind instruments, it both receives and expels the wind: it dilates like a bag, so as to receive the wind in the cheeks; and it contracts upon the wind so as to expel the wind, and to swell the note: In blowing the strong wind instruments, we cannot blow from the lungs, for it stresses the breathing, but reserve the air in the mouth, which we keep continually full; and from this it is named, from blowing the trumpet, the BUCCINATOR.

Depressor anguli oris.

XI. DEPRESSOR ANGULI ORIS. — The depressor anguli oris is a neat small triangular muscle, and is indeed very commonly named MUSCULUS TRIANGULARIS LABIORUM, from its shape. The base of the triangle is at the line of the lower jaw, where the muscle rises with a fat fleshy edge, more than an inch in breadth. It grows smaller gradually as it rises towards the corner of the mouth, where it is implanted, small almost in a point, and directly opposite to the zygomatic and levator muscles; and as the zygomatic muscle makes a line from the cheek down to the angle of the mouth, this makes a line from the chin up to the corner of the mouth. It is chiefly active in expressing the passions, and gives form to the chin and mouth. In cheerful motions, as laughter, smiling, &c. the zygomatics and levators pull the angles of the mouth upwards. In fear, hatred, revenge, contempt, and the angry passions, the triangulares pull the corners of the mouth downwards; and at the place where these meet, there is formed a sort of rising at the angle of the mouth: for a great many tendons are crowded into this one point; the zygomatic, levator, depressor, and orbicularis oris muscles meeting and crossing each other at this place.

Or. the base of the lower jaw near the chin.

In. the angle of the mouth.

Depressor labii inferioris.

XII. The DEPRESSOR LABII INFERIORIS is a small muscle, the discovery of which Cowper claims for himself. It is a small muscle, lying on each side of the chin, which, with its fellow, resembles very much the levators of the upper lip. The depressor labii

Or. base of lower jaw.

inferioris arises on each side of the chin, from the lower jaw-bone, under the line of the triangular muscle. It grows obliquely upwards and inwards, till it meets its fellow in the middle of the lip; and where the muscles of the opposite side meet, there is a little filtrum or furrow on the lower lip, as on the upper one. It mixes its fibres with the orbicularis, and its use is to pull the lip downwards; each muscle is of a square form, and thence has been often named QUADRATUS GENÆ, the square muscle of the chin. To middle of lower lip.

XIII. The ORBICULARIS ORIS, or muscle round the mouth, is often named CONSTRICTOR ORIS, SPHINCTER, or OSCULATOR. It is very regular; it is an inch in breadth, and constitutes the thickness of the lips: it lies in the red part of the lips, and is of a circular form, surrounding the mouth after the same manner that the orbicularis oculi encircles the eye. We see a degree of crossing in the fibres at the angles of the mouth, whence it has been considered by many not as a circular muscle, but as one consisting of two semicircular muscles, the SEMI ORBICULARIS SUPERIOR, and SEMI ORBICULARIS INFERIOR. Its fixed points are the two angles of the mouth; at that swelling which is formed by the union of the zygomatic, triangular, and other muscles, part of it takes origin from the alveolar processes of the canine teeth. The chief use of this muscle is to contract the mouth, and antagonize the other muscles which I have just described. Often a small slip runs up from the middle of the upper lip to the tip of the nose; it is the NASALIS LABII SUPERIORIS of Albinus: it lies exactly in the furrow of the filtrum, and is occasionally a levator of the upper lip, or a depressor of the tip of the nose. Orbicularis oris. Attached to the alveolar process. Nasalis labii superioris.

These muscles of the nose and lips are not useful merely in expressing the passions; their great office is to perform those continual movements, which breathing, speaking, chewing, swallowing, require. There are muscles for opening the mouth in various directions, which are all antagonized by this one, Their action.

the orbicularis oris. The levator labii superioris, and the depressor labii inferioris, separate the lips and open the mouth. The levator anguli oris, along with the zygomatic muscles, raises the cheek, and dilates the corners of the mouth. The buccinator pulls the corner of the mouth directly backwards, opening the mouth. The angularis oris also dilates the mouth, pulls the angles of the mouth downwards and backwards, and forms it into a circle, if the others act at the same time; but the orbicularis oris is the largest and strongest, (formed, as it were, by the fibres of all these, taking a new direction, and turning round the lips,) shuts the mouth, and antagonizes them all, and from an opening as wide as the mouth can require, shuts the mouth at pleasure, so closely, as to retain the very breath against all the force of the lungs. It is the true antagonist of all the other muscles, and they and the orbicularis mutually re-act on each other, in alternately opening and closing the mouth. This phenomenon of the orbicularis muscle, dilating to such a wideness, and in an instant closing the mouth again, with such perfect accuracy, as to retain the breath, puts to nought all the vain calculations about the contraction of muscles, as that they can contract no more than one third of their length; for here is an infinite contraction, such as no process can measure. It is a paralysis of these muscles that so often occasions a hideous distortion of the face; for when one side of the body falls into palsy, the muscles of one cheek cease to act; the muscles of the other cheek continue to act with their usual degree of power. This contraction of the muscles of one cheek excites also the orbicularis oris to act, and so the mouth is pursed up, and the lips and angles of the mouth are drawn towards one side.

There are some smaller muscles, which, lying under these, could not be described without danger of confusion; as

Depressor alæ nasi.

XIV. The DEPRESSOR LABII SUPERIORIS and ALÆ NASI, which is very small, and lies concealed under

the other muscles. It rises from the gum or socket of the fore teeth, and thence is named, by Winslow, incisivus medius. It goes into the root of the nostril, and pulls it, and, of course, the upper lip down, and is named, by Albinus, depressor alæ nasi.

Or. alveolar pro. of the incisores and canine teeth. *In.* corner of the ala of the nose, and part of the upper lip.

XV. The CONSTRICTOR NASI, or compressor of the nose, is a small scattered bundle of muscular fibres, which crosses the wings, and goes to the very point of the nose; for one arises from the wing of the nose on each side, and meets its fellow in the middle ridge, where both are fixed into the middle cartilage, or into the lower point of the NASAL bones meeting with the peak of the frontal muscle, or its scattered fibres. But this muscle is so difficultly found, that when Cowper saw it distinctly marked in Bidloo's 12th table, he considered it as a fiction, having sought for it very carefully, but in vain.

Compressor naris. *Or.* int. point of os. nasi, and nasal pro. of sup. max. bone. *In.* root of the ala nasi.

And XVI. The LEVATOR MENTI, which arises from the lower jaw, at the root of the cutting tooth, has been named INCISIVUS INFERIOR. It is inserted into the skin, on the very centre of the chin: by its contraction it draws the centre of the chin into a dimple; and from its moving the under lip at the same time, it is named LEVATOR LABII INFERIORIS; sometimes the SUPERBUS.

Levator labii inferioris. *Or.* alveoli of the incisores and caninus. *In.* chin.

MUSCLES OF THE EXTERNAL EAR.

Though perhaps not one of ten thousand has the power of moving the outward ear, yet there are many thin and scattered fibres of muscles about the root of the cartilage of the ear, to which we cannot refuse the name and distinction of muscles; and which serve, indeed, to indicate, that nature had intended a degree of motion, which, perhaps by the manner of covering the heads of children, we may have lost. But in a few, these fasciculi of fibres have not the form only, but the uses of muscles. The celebrated Mr. Mery was wont, when lecturing on this subject, to amuse his pupils, saying, pleasantly, "that in one thing, he surely belonged to

the long ear'd tribe;" upon which, he moved his ears very rapidly backwards and forwards.*

Superior auris.

XVII. SUPERIOR AURIS is named attollens because it lifts the ear upwards: it is a very thin, flat expansion, which can hardly be distinguished from the fascia of the temporal muscle, upon which it lies; it arises broad and circular, from the expanded tendon of the occipito-frontalis, and is inserted into the back part of the antihelix.

Or. tendon of occipito-frontalis. *In.* back part of the antihelix.

Anterior auris. *Or.* zygomatic pro. *In.* the point of the helix that divides the concha.

XVIII. ANTERIOR AURIS is a very delicate, thin, and narrow expansion, arising about the zygoma, or rather from the fascia, with which the zygoma is covered: it is inserted by a tendon into that eminence of the helix which divides the concha.

Posterior auris. *Or.* mastoid process. *In.* back part of the concha.

XIX. The POSTERIOR AURIS is also a small muscle, very delicate and thin; but the anterior rises in one small and narrow slip only, while this, the posterior, rises, commonly, in three narrow and distinct slips, from about the place of the mastoid process†; whence it is often named TRICEPS AURIS. These fibres are often described as two distinct muscles, retrahentes: it goes directly forwards to be inserted into the back part of the concha, opposite the septum that divides the concha, by two slips.

But there are still other muscles enumerated, which are not for moving the outward ear upon the head, but for moving, or rather giving tension to the cartilages of the outward ear. They, in all probability, prepare the cartilages of the ear for receiving and propagating the vibrations of sound inwards along the tube of the ear.

The ring and other bendings of the outward ear are called helix and antihelix, tragus and antitragus; and this determines the names of these ambiguous fibres, which are sometimes found lying upon these circles of the outward cartilage, just under the skin.

XX. The MUSCULUS HELICIS MAJOR lies upon the upper or sharp point of the helix or outward ring;

* Vide Palfin, who was his pupil. The celebrated Albinus could move his ears.

† Fibræ carneæ transversæ, a nobis descriptæ VALSALVA.

rising from the upper and acute point of the helix, and inserted into the same cartilage a little above the tragus.

XXI. Helicis minor rises lower than the former, upon the fore part of the helix, and runs across the notch which is in that part of the helix that projects into the concha, the muscle having its origin above the notch, and its insertion below it.

XXII. The tragicus lying upon the concha, and stretching to the tragus, takes its origin from the middle of the concha to the root of the tragus, and is inserted into the tip of the tragus.

XXIII. The antitragicus lies on the antitragus, running up from this cartilage to be inserted into the edge of the concha, at the notch on the termination of the helix.

XXIV. And, lastly, There is the transversus auris of Albinus, which runs in scattered fibres on the back part of the ear from the prominent part of the concha to the outer side of the antihelix.

MUSCLES OF THE EYE-BALL.

The eye-ball is entirely surrounded by muscles, which turn it in all directions. There is one muscle on either side, one above and one below; these arise from the very bottom of the socket, spread out upon the ball of the eye, and are implanted into its fore part, where the expansions of their colourless tendons form what is called the white of the eye. Now these four muscles, coming in a straight course from the optic foramen to the anterior part of the eye-ball, are called the recti, or straight muscles: for their pulling is from the bottom of the socket. But there are two other muscles which are named the oblique muscles, because they pull from the edges of the socket, and turn the eye obliquely; for they go in a direction exactly opposite to the recti. The recti come directly forwards, from the bottom of the orbit; these go obliquely backwards, from the

edge of the orbit; one rises from the lower edge of the socket, and goes backwards under the eye-ball; the other rises, indeed, along with the recti, in the bottom of the socket, but it has a cartilaginous pulley on the very edge of the socket, at its upper part; and its small round tendon first runs through this pulley, and then turns down upon the eye, and goes backwards; so that the straight muscles press down the eye-ball deep into the socket, while the oblique muscles bring the eye-ball forwards, pulling it outwards from the socket.

The truest description of the recti is as of one muscle, since their only variety is that difference of place, which is expressed by the name of each.

They all agree in these chief circumstances, that they arise by flat, but small tendons, round the margin of the optic hole, arising from the circle of that hole, or rather from the periosteum there; and there being one above, one below, and one on either side, they completely surround the optic nerve, and adhere to it. They are neat and delicate muscles, which gradually expand each into a fleshy belly, which surrounds and covers the middle of the ball of the eye. They still go on expanding, till they at last terminate, each in a broad, flat, and very wide tendon, which covers all the fore part of the eye, up to the circle of the lucid cornea or window; and their white and shining tendons form that enamelled-like part, which lies without the coloured circle, and which is named the white of the eye, or the TUNICA ALBUGINEA, as if it were absolutely a distinct coat.

Now, the only difference in these straight muscles is in respect of length; for the optic nerve enters the eye, not regularly in the centre, but a little towards the inner side, so that the rectus internus, or muscle nearest the nose, is a little shorter. The rectus externus, or muscle nearest to the temple, is a little longer: but the rectus superior and the rectus inferior are of equal length. The uses of these muscles are exceedingly plain.

XXV. The RECTUS SUPERIOR, lifting the eye directly upwards, is named the MUSCULUS ATTOLLENS, the LEVATOR OCULI or SUPERBUS, as expressive of haughtiness and pride.

XXVI. And the RECTUS INFERIOR, which is directly opposite to it, is named DEPRIMENS OCULI or HUMILIS, as expressing modesty and submission.

XXVII. The RECTUS INTERNUS is called ADDUCENS, as carrying the eye towards the nose, or BIBITORIUS, because it directs the eye to the cup.

And (XXVIII.) the RECTUS EXTERNUS, the outer straight muscle, as it turns the eye away, is named ABDUCTOR OCULI, or INDIGNABUNDUS, expressing anger or scorn. Such is the effect of these muscles; that when they act in succession, they roll the eye; but if they act all at once, the power of each is balanced by the action of its opposite muscle, and the eye is immoveably fixed. So that sometimes in our operations, when the couching needle approaches the eye, fear comes upon the patient, and the eye is fixed by a convulsive action, more firmly than it could be by the instruments, or by the finger; so that the speculum oculi is after such an accident of no use. The eye continues fixed during all the operation, but it is fixed in a most dangerous way, by a power which we cannot controul, and which sometimes, when our operation is for extracting one of the humours only, squeezes out the whole.

XXIX. The OBLIQUUS SUPERIOR or TROCHLEARIS arises along with the recti in the bottom of the eye above, and towards the inner side, directing its long tendon towards the inner angle of the eye; and there it passes its tendon through that pulley, whose hollow I have marked in describing the os frontis, as under the superciliary ridge, and near to the inner corner of the eye. It arises by a small tendon like one of the recti; it goes over the upper part of the eye-ball, a long and slender muscle, whence it is often named LONGISSIMUS OCULI, the longest muscle of the eye. It forms a small smooth round tendon, which passes through the ring of the cartilaginous

Obliquus superior.

Or. edge of the foram. opticum.

pulley, which is in the margin of the socket. The pulley is above the eye, and projects farther than the most prominent part of the eye-ball, so that the tendon returns at an acute angle, and bends downwards before it can touch the eye-ball. And it not only returns backwards in a direction opposite to the recti muscles, but it slips flat under the body of the rectus superior, and is spread out under it upon the middle or behind the middle of the eye, viz. about half way betwixt the insertion of the rectus, and the entrance of the optic nerve.

In. the sclerotic, half way between the insertion of rect. sup. and entry of the optic nerve.

Obliquus inferior.

XXX. The OBLIQUUS INFERIOR is, with equal propriety, named the musculus brevissimus oculi. It is directly opposite to the obliquus superior in form, place, office, &c. for it arises from the orbitary process of the superior maxillary bone, near its union with the os unguis: it is short, flat, and broad, with a strong fleshy belly: it goes obliquely backwards and outwards, lying under the ball of the eye; and it is inserted broad and flat into the ball, exactly opposite to the insertion of the obliquus superior muscle.

Or. outer edge of orb. pro. of sup. max. bone.

In. sclerotica opposite the obliquus superior.

These two muscles are said to roll the eye, whence they are named musculi circumagentes, or amatorii. It was Winslow's opinion that they had another office, viz. supporting the eye-ball, for the operation of its straight muscles: for when the obliqui act, they pull the eye forwards, the straight muscles resist, and the insertion of the oblique muscles at the middle of the eye-ball becomes, as it were, a fixed point, a centre or axis round which the eye-ball turns under the operation of the recti muscles. The conjoined effect of the oblique muscles is to bring the eye-ball forwards from the socket. The particular effect of the upper oblique muscle is not to bring the eye forward, but to roll the eye so as to turn the pupil downwards, and towards the nose. And the particular effect of the lower oblique muscle is to reverse this action, to turn the eye again upon its axis, and to direct the pupil upwards and outwards; but still there is some difficulty here, for if the question be

put, — does not the eye-ball roll in all directions? we must answer that it does: which, if it were in any measure accomplished through the operation of the oblique, there should be four, and not two.*

MUSCLES OF THE LOWER JAW, THROAT, AND TONGUE.

MUSCLES OF THE LOWER JAW.

The lower jaw requires muscles of great power to grind the food; and accordingly it is pulled upwards by the strong temporal, masseter, and pterygoid muscles; but, in moving downwards, the jaw almost falls by its own weight, and having little resistance to overcome, any regular appointment of muscles for pulling down the jaw is so little needed, that it is pulled downwards by muscles of such ambiguous office, that they are equally employed in raising the throat, or pulling down the jaw, so that we hardly can determine to which they belong; for the chief muscles of the throat, coming from the lower jaw, must, when the jaw is fixed, pull up the throat, or when the throat is fixed, depress the jaw.

XXXI. The TEMPORAL MUSCLE is the great muscle of the jaw.† It arises from all the flat side of the parietal bone, and from the sphenoid, temporal, and frontal bones, in that hollow behind the eye, where they meet to form the squamous suture. It arises also from the inner surface of that strong tendinous

Temporalis. Or. 1. semicircular ridge of parietal bone. 2. Pars squamosa of temporal b.

* The subject of the action of these muscles is taken up again, when discussing the physiology of the eye. See Vol. III.

† *Temporal Fascia.*—Before dissecting these muscles of the jaw, the student must make himself acquainted with the strong *fascia* which covers the side of the head, and covers the temporal muscle. This strong tendinous web is continued from the pericranium of the temporal ridge of the os frontis, and from the jugum; it extends over the temporal muscle, and is attached to the ridge of the parietal bone, where it may be again traced into the pericranium. The surgeon has to take particular notice of this fascia, for, in wounds of the head, when matter gets under it, the fluid sinks deep, and perhaps appears at the angle of the jaw.

3. ex. ang. pro. of frontal bone. 4. temporal plate of the sphenoid. 5. zygomatic process. 6. from a fascia covering the muscle.

membrane which is extended from the jugum to the semicircular ridge of the parietal bone. The fibres are bundled together and pressed into a small compass, so that they may pass under the jugum: there they take a new hold upon the inner surface of the jugum; the muscle is of course pyramidal, its rays converging towards the jugum; its muscular fibres are intermixed with strong tendinous ones; it is particularly tendinous where it passes under the jugum; and it has both strength and protection from that tendinous plate which covers it in the temple. Its insertion is into the coronoid process of the lower jaw-bone; not merely into the tip of the horn, but embracing it all round, and down the whole length of the process, so as to take the firmest hold.

In. the coronoid pro. of inferior max. bone.

Masseter.

Or. 1. sup. max. bone. 2. the os malæ, and 3. the zygoma in its whole length.

In. outside of the angle and the base of the inf. maxilla.

XXXII. The MASSETER is a short, thick, and fleshy muscle, which gives the rounding of the cheek at its back part. It arises from the upper jaw-bone, at the back of the antrum, and under the cheek-bone, and from the lower edge of the zygoma. It lies upon the outside of the coronoid process, covering the branch of the lower jaw quite down to its angle. It is particularly strong, has many massy bundles of flesh, interspersed with tendinous strings. Indeed, in dissection, this muscle may be divided into two portions, which cross each other obliquely; which reminds us that the action of the muscle is not simply to close the teeth, but also to produce the lateral or grinding motions of the jaw. The jaw is very firmly pulled up by these two, which are its most powerful muscles; and when we bite, we can feel the temporal muscle swelling on the flat part of the temple, and this, the masseter, upon the back part of the cheek. The parotid gland lies on its upper part, and the duct of the gland (as it crosses the cheek) lies over this muscle.

Pterygoideus internus.

Or. 1. Inner and upper part of internal

XXXIII. XXXIV. The two PTERYGOID MUSCLES (of which there are four in all, two on each side,) are named from their origin in the pterygoid processes of the sphenoid bone. The PTERYGOIDEUS INTERNUS is that one which rises from the internal or flatter

pterygoid process, and which goes downwards and outwards to the angle of the jaw on its inside; it fills up the fossa pterygoidea.

pterygoid process. 2. the palatine bone.

In. inside of the angle of the inf. max. bone.

The PTERYGOIDEUS EXTERNUS arises from the outside of the external plate of the pterygoid process of the sphenoid bone, and from the adjoining part of the upper maxillary bone. It is inserted into the neck of the condyle of the lower jaw-bone, the upright part of the bone, and to the capsule of the joint.

Pterygoideus externus.

Or. 1. external plate of pterygoid process. 2. the maxillary bone.

In. the neck and upright part of maxilla.

The jaw is moved chiefly by these muscles; the temporalis acting upon the coronoid process like a lever, the masseter acting upon the angle, and before it, and the pterygoideus internus balancing it within, like an internal masseter fixed on the inside of the angle. All these pull strongly upwards for biting, holding, and tearing with the teeth; and the external or lesser pterygoid muscle, going from within outwards, pulls the jaw from side to side and performs the motion of grinding.

MUSCLES LYING ON THE FORE PART OF THE NECK, AND MOVING THE HEAD.

Although we might now, following the order of functions, be directly led to treat of the muscles of the tongue and throat, yet we shall, in the first place, dismiss those, which in dissection, must be first exposed upon the fore part of the neck.

XXXV. PLATYSMA MYOIDES. — This is a very thin muscular expansion, which is spread over the other muscles of the neck and throat, and extends upwards, upon the lower part of the face. It arises by scattered fibres, which are attached to the cellular membrane, betwixt the pectoral and deltoid muscles and the skin of the chest. It extends upwards and forwards, over the clavicle and the mastoid muscle, going like a thin integument over the neck. It terminates on the face and jaw. Some of its fibres, mounting over the bone of the jaw, are inserted near the depressor anguli oris; and others, a little higher on the face, are called RISORIUS SANTORINI.

Platysma myoides.

Or. superficially on the upper part of the chest.

In. the integuments covering the jaw and face.

Use.

This muscle supports the parts in the neck, as fasciæ do elsewhere; it compresses veins, and forces the blood down into the chest, when there is difficult respiration. It is, in truth, more a muscle of respiration and circulation, than for the motion of parts, or even for expression; yet it is very active in the expression of the stronger passions. In dissecting this muscle the surgical student will have a regard to a very important part of the surgical anatomy of the neck. Although there be no proper fascia investing the neck, for very obvious reasons, yet the fibres of this muscle interlacing with the common cellular membrane, form a pretty dense and firm covering. It will be noticed in dissection, that this compound web is very particularly connected to the transverse processes of the vertebræ, to the mastoid process, and to the angle of the jaw. It will be found, also, to be connected to the clavicle and first rib, and to make a sort of septum betwixt the region of the neck and the thorax.

The reason of the difference in the texture of this web in comparison with the fascia of the extremities, is to provide for the freedom of the trachea, and to permit its easy motion.

Mastoideus.

XXXVI. Sterno-cleido mastoideus. — This is the most conspicuous and finest muscle of the body, giving the fleshy roundness of the neck, and when in action rising to produce the most beautiful contour of the neck, both in man and woman. Its origin and insertion are shortly described in its name, sterno-cleido mastoideus. It arises from the triangular portion of the sternum, by a strong round tendon, and from the sternal portion of the clavicle, by a broader and more fleshy origin. It ascends upon the neck, and in such a manner, that the dissector can separate the two portions with the handle of his scalpel, to their termination. It is inserted into the mastoid process of the temporal bone, and extends its attachment backwards upon the mastoid angle of that bone.

Or. 1. sternum. 2. the clavicle.

In. the mastoid process, and angle of the temporal bone.

When the muscles of both sides act together, they pull the head downwards, and bring the chin to the breast; but when one muscle acts, it pulls down the ear to the shoulder, and so twists the neck, as to throw the chin a little up, and to the other side. This effect of the single muscle it is important to notice, because this muscle is subject to a disease which produces wry neck; and it requires a knowledge of anatomy to distinguish the different causes of this distortion, whether arising from paralysis or disease of muscle, or affection of the spine, &c. Action.

MUSCLES OF THE THROAT AND TONGUE.

The MUSCLES of the THROAT and TONGUE cannot be understood without a previous acquaintance with certain cartilages and bones, which form the basis of the throat and tongue, and the centre of those motions which we have next to describe.

The OS HYOIDES is a small bone resembling in shape at least the lower jaw-bone. It has a middle thicker part, named its basis, which is easily felt outwardly; it corresponds in place with the chin, and during life it is distinguished about an inch below the chin, the uppermost of the hard points which are felt in the fore part of the throat. Next, it has two long horn-like processes, which go backwards along the sides of the throat, called the cornua, or horns of the os hyoides, and which are tied by a long ligament to the styloid process of the temporal bone. And, lastly, it has small cartilaginous pieces or joinings, by which the horns are united to the basis; and often in the adult this joining is converted into bone. At this point, where the two horns go backwards, like the legs of the letter U, there are commonly, at the gristly part of the os hyoides, two small perpendicular processes which stand up from the joining of the horns to the body, and these are named the appendices of the os hyoides, or the lesser cornua.

Now, this os hyoides forms by its basis the root of the tongue, thence it is often named the bone of the tongue. It forms at the same time a part of the larynx, which is the collection of cartilages forming the top of the trachea, or windpipe; and it carries upon it that cartilage named epiglottis, which, like a valve, prevents any thing getting down into the windpipe. Its horns extend along the sides of the throat, keeping the openings of the windpipe and gullet extended, as we would keep a bag extended by two fingers. The chief muscles of the tongue and of the windpipe arise from its body; the chief muscles of the gullet arise from its horns, and especially from their points; it receives the chief muscles which either raise or depress the throat; and it is the point d'appui, or fulcrum, for all the muscles of the throat and tongue, and the centre of all their motions. It is the centre of the motions of the tongue, for it is the origin of these muscles which compose chiefly the bulk of the tongue; of the motions of the trachea or windpipe, for it forms at once the top of the windpipe, and the root of the tongue, and joins them together; of the motions of the pharynx or gullet, for its horns surround the upper part of the gullet, and join it to the windpipe; and it forms the centre for all the motions of the throat in general: for muscles come down from the chin to the os hyoides, to move the whole throat upwards; others come up from the sternum, to move the throat downwards; others come obliquely from the coracoid process of the scapula, to move the throat backwards, while the os hyoides still continues the centre of all these motions.

The TRACHEA, or WINDPIPE, is that tube which conveys the air to the lungs; and the larynx is the head or figured part of that tube which is formed like a flute for the modulation of the voice, and consists of cartilages, that it may stand firm and uncompressed, either by the passage of the food, or by the weight of the outward air; and that it might resist the contraction of the surrounding parts,

serving as a fulcrum for them in the motions of the jaw, tongue, and gullet. Its cartilages are, first, the SCUTIFORM, or THYROID cartilage, which is named from its resemblance to a shield, or rather it is like the flood-gates or folding doors of a canal, the meeting of the two sides being in the middle line of the throat. This prominent line of the thyroid cartilage is easily felt in the middle of the throat, is about an inch in length, and makes that tumour which is called the pomum Adami. The flat parts of the thyroid cartilage form the sides of the larynx. And there are two long horns at its two upper corners, which rise like hooks above the line of the cartilage, and are joined to the horns of the os hyoides, and two similar but shorter hooks below, by which it embraces the cricoid cartilage.

The CRICOID CARTILAGE is next to the thyroid, and below it; it is named from its resemblance to a ring.* It is indeed like a ring or hoop, but it is not a hoop equally deep in all its parts, it is shallow before, where it ekes out the length of the thyroid cartilage, and is deeper behind, where it forms the back of this flute-like top of the trachea; it is the top ring of the trachea, and the lower ring of the larynx or flute-part of the windpipe. And upon its back, or deeper part, are seated those two small cartilages, which, with their ligaments, form the opening for the breath.

The ARYTENOID CARTILAGES† are two small triangular bodies, seated within the protection of the thyroid cartilage. They are foolishly described with cornua, ridges and surfaces, when they are so small that nothing further can be observed of their forms, than that they are somewhat conical; that the base or broad part of each sits down upon the upper edge of the cricoid cartilage at its back; that the point of each stands directly upwards, and is a very little crooked, or hook-like; that standing, as they do, a

* From κρικος, a ring.
† From αρυταινα, an ewer, and ειδος, like.

little apart from each other, they form together an opening something like the spout of an ewer, whence their names. And these cartilages being covered with the common membrane of the throat, which is thick, and full of mucous glands, the opening gets a regular appearance with rounded lips. From the bases of these cartilages to the back part of the thyroid cartilages ligaments called the *cordæ vocales* are extended; over these ligaments the lining membrane of the larynx is laid, and betwixt them is formed the chink or rima glottidis; viz. the opening of the windpipe. The voice is, in a considerable degree, formed by the motion of these cartilages and their ligaments, and the action of the muscles of the arytenoid cartilages are so exquisitely minute, that for every changing of the note (and there are some thousand gradations in the compass of the voice) they move in a proportioned degree.

The EPIGLOTTIS is a fifth cartilage of the trachea, belonging to it both by connection and by office. It is a broad triangular cartilage, not so hard as the others, very elastic, and so exactly like an artichoke leaf, that no other figure can represent it so well. Its office is to defend the opening of the glottis. It is fixed at once to the os hyoides, to the thyroid cartilage, and to the root of the tongue, and it hangs obliquely backwards over the opening of the rima, or chink of the glottis; it is suspended by little peaks of the membrane, which we call ligaments of the glottis, and it is said to be raised or depressed by muscles, which yet are not very fairly described. But the rolling of the morsel which is swallowed, and the motion of the tongue, are sufficient to lay it flat over the rima, so that it is a perfect guard upon the windpipe.

Then this is the constitution of the larynx. It is of hard cartilages to resist compression, and of a flute form at its opening, to regulate the voice. The THYROID cartilage is the great one, the chief defence before, and which has edges slanting far backwards, to defend the opening of the larynx.

The CRICOID cartilage, which forms the upper ring of the trachea, supports the arytenoid cartilages, and by its deepness behind raises them so, that the opening of the glottis is behind the middle of the great thyroid cartilage, and in the deepest part of it, well defended by its projecting wings. The ARYTENOID cartilages and ligaments form the rima glottidis, the chink by which we breathe; which, as it is narrower or wider, modulates and tunes the voice; the opening of which is so exquisitely moved by its muscles in singing, widening or contracting in most delicate degrees, and which is so spasmodically shut by the same muscles when it is touched by a drop of water, or by a crumb of bread; but the valve of the glottis, the EPIGLOTTIS, standing over it, flaps down like the key of a wind instrument, so that the rareness of such accidents is wonderful, when we consider that the least attempt to draw the breath, while we are swallowing, will produce the accident.

The muscles which move the tongue and throat must be far too complicated to be explained at all, without some previous knowledge of these parts; and still, I fear, not easily to be explained with every help of regularity and order.

MUSCLES OF THE THROAT.

By this arrangement, I mean to include under one class all those muscles which move the os hyoides or the larynx; and through these, as centrical points, move the jaws, gullet, and tongue; and which, though they are inserted into the larynx, have more relation to swallowing, or the motions of the gullet, than to breathing, or to the motions of the windpipe.

The muscles which pull the throat down are these:

XXXVII. The STERNO-HYOIDEUS, which passes from the sternum to the os hyoides, a flat, broad, ribbon-like muscle, arises from the upper piece of the sternum, rather within the breast, and partly also from the clavicle and cartilage of the first rib, goes

Sterno-hyoideus.
Or. 1. cartil. of first rib. 2. upper and inner part of sternum,

2. the clavicle near the sternum. In. base of the os hyoides.

flat and smooth along the fore part of the throat, mounts nearly of the same breadth to the os hyoides, and is implanted into its basis, or that part (which in comparing the os hyoides to the jaw) we should compare with the chin.

Sterno-thyroideus.

XXXVIII. The STERNO-THYROIDEUS, which passes in like manner from the sternum to the thyroid cartilage, is like the last, a flat, smooth, ribbon-like muscle, rather thicker and more fleshy, but very uniform in its thickness. As the thyroid cartilage is below the os hyoides, the sterno-thyroid muscle must lie under the sterno-hyoideus muscle. It arises under the sterno-hyoideus muscle from the sternum and cartilage of the rib, and is implanted into the rough line of the lower edge of the thyroid cartilage, and a little to one side, but not so much as is represented in Cowper's drawings. It immediately covers the thyroid gland.

Or. 1. the sternum, 2. the cartilage of first rib. In. lower edge of thyroid cartilage.

Omo-hyoideus.

XXXIX. The OMO-HYOIDEUS, which was once named CORACO-HYOIDEUS, being thought to arise from the coracoid process, is a muscle of great length, and very slender; reaches from the shoulder to the os hyoides; it is, like these last mentioned, a long, flat, strap-like muscle, as flat and as fleshy, but not so broad as either of the former. It lies along the side of the neck; is pinched in a little in the middle, where it is divided by a tendinous cross line, which separates the fleshy belly into two heads, whence it has frequently the name of digastricus inferior. It arises from the upper edge of the scapula, which is called costa, near its notch, and from the ligament that crosses the notch, and is implanted into the side of the os hyoides, where the horn goes off from the body of the bone.

Or. sup. costa near the notch of the scapula. In. base of os hyoides opposite the lesser cornu.

These three muscles pull down the throat. The sterno-hyoideus and sterno-thyroideus pull it directly downwards: one of the omo-hyoidei acting, pulls it to one side; but if both act, they assist in pulling directly down, and bracing the trachea at the same time a little down to the back. These muscles are in almost constant action, and are perfectly

relaxed only during the action of deglutition, when they yield to let the throat be drawn up, and the mouth thrust back.

The muscles which move the throat upward are:

XL. The MYLO-HYOIDEUS, a flat and broad muscle, which arises from the whole semicircle of the lower jaw, *i. e.* from the alveoli of the backmost grinders to the point of the chin. It rises from a line on the inner surface of the lower jaw-bone, goes down to the basis of the os hyoides, proceeds with very regular, straight, distinct, and orderly fibres, from the jaw to the os hyoides, is plainly divided in the middle from the symphysis of the jaw to the middle of the os hyoides, by a middle tendinous and white line. And though Cowper denies the authority of Vesalius, who divides it thus, it is plainly two distinct muscles one belonging to either side.

Mylo-hyoideus.

Or. from the line or ridge on the inside of the jaw.

In. 1. lower edge of the body of the os hyoides. 2. its fellow, by a white line.

XLI. The GENIO-HYOIDEUS is a small neat pair of muscles, arising from the chin at a rough point which is easily distinguished within the circle of the jaw. The mylo-hyoideus is named from the whole jaw. The genio-hyoideus is named from the chin, arising from a small tubercle behind the chin; its beginning is exceedingly narrow: as it proceeds downwards, it grows flat and broad; it is implanted into the basis of the os hyoides by a broad edge, and is a beautiful and radiated muscle. The submaxillary gland lies flat betwixt this muscle and the last, and in the middle the submaxillary duct pierces the membrane of the mouth, to open under the root of the tongue. The two muscles move the os hyoides forwards and upwards when the jaw is fixed; but when the os hyoides is fixed by the muscles coming from the sternum, these muscles of the os hyoides pull down the jaw.

Genio-hyoideus.

Or. tubercle on the inside of the symphysis of the lower jaw.

In. the body of the os hyoides under the mylo-hyoideus.

XLII. The STYLO-HYOIDEUS is one of three beautiful and slender muscles which come from round the styloid process, which all begin and end with slender tendons, and with small fleshy bellies; and one going to the pharynx or gullet, another to the os hyoides, and a third to the tongue, they coincide in one com-

Stylo-hyoideus.

mon action of drawing back the tongue, and pulling the throat upwards.

Or. the lower half of the styloid process.

This one, the stylo-hyoideus, arises from about the middle of the styloid process, and, going obliquely downwards and forwards, is fixed into the side of the os hyoides, where the basis and horn are joined. Above its insertion, its fibres are split, so as to make a neat small loop, through which the tendon of the digastric muscle runs. This stylo-hyoideus is sometimes accompanied with another small fleshy muscle like it, and of the same name, which was first, perhaps, observed by Cowper, and has been named by Innes STYLO-HYOIDEUS ALTER; but it is not regular, nor has it ever been acknowledged as a distinct muscle.

In. the os hyoides at the union of base and horn.

Digastricus.

XLIII. The DIGASTRICUS or BIVENTER MAXILLÆ INFERIORIS muscle is named from its having two bellies. One belly arises from a rugged notch along the root of the mastoid process, where the flesh is thick and strong; going obliquely forwards and downwards, it forms a long slender tendon, which passes by the side of the os hyoides; and as it passes, it first slips through the loop or noose of the stylo-hyoideus, and then is fixed by a tendinous bridle to the side of the os hyoides; and then turning upwards towards the chin, it ends in a second fleshy belly, which, like the first, is flat and of a pyramidal shape, lying above the mylo-hyoideus; and is inserted into a rough part of the lower jaw, on the inside of the circle.

Or. groove in mastoid pro. of temporal bone.

In. fixed by a lig. to os hyoides, and, turning up, is inserted into a rough surface under the chin.

Though this muscle is often called biventer maxillæ inferioris, as belonging to the lower jaw, perhaps it does more regularly belong to the throat. No doubt, when the os hyoides is fixed by its own muscles, from the shoulder and sternum, the digastricus must act on the jaw; an office which we cannot doubt, since we often feel it taking a sudden spasm, pulling down the chin with severe pain and distortion of the neck. But its chief office is raising the os hyoides; for when the jaw is fixed, as in swallowing, the os hyoides pulls up the throat; and this is

the true meaning of its passing through the noose of the stylo-hyoideus, and of its connection with the side of the os hyoides. Then the digastricus and stylo-hyoideus muscles pull the throat upwards and backwards.

The muscles which move the parts of the larynx upon each other are much smaller, and many of them very minute.

XLIV. The HYO-THYROIDEUS goes down, fleshy and short, from the os hyoides to the thyroid cartilage. It arises from the lower border of the thyroid cartilage, where the sterno-thyroideus terminates, and goes up along the side of the thyroid cartilage, like a continuation of the sterno-thyroideus muscle. It passes the upper border of the thyroid cartilage, and is fixed to the lower edge of the os hyoides, along both its base and part of its horn.

Hyo-thyroideus. *Or.* lower edge of thyroid cartilage. *In.* part of base and almost all the cornu of os hyoides.

XLV. The CRICO-THYROIDEUS is a very short muscle, passing from the upper edge of the cricoid to the lower margin of the thyroid cartilage, chiefly at its side, and partly attached to its lower horn, which comes down clasping the side of the CRICOID ring, so that it is broader above, and a little pointed below.

Crico-thyroideus. *Or.* side and fore part of cricoid cartilage. *In.* 1. the base. 2. inferior cornu of the thyroid cartilage.

These two small muscles must have their use, and they bring the thyroid cartilage nearer to the os hyoides, and the cricoid nearer to the thyroid cartilage; and by thus shortening the trachea, or compressing it slightly, they may perhaps affect the voice; but the muscles on which the voice chiefly depends are those of the RIMA GLOTTIDIS; for there are many small muscles which have their attachment to the arytenoid cartilages, and which, by their operation on the thyro-arytenoid ligament, govern the rima glottidis.

XLVI. The MUSCULUS ARYTENOIDEUS TRANSVERSUS is that delicate muscle which contracts the glottis by drawing the arytenoid cartilages towards each other. It lies across, betwixt them at their back part; it arises from nearly the whole length of one arytenoid

Arytenoideus transversus. *Or.* side of one arytenoid cartilage.

In. side of the other ary. cart. cartilage to go across, and be inserted into the same extent of the opposite one.

Arytenoideus obliquus. *Or. base of the one ary. cartilage.* *In. apex of the other ary. cart.*

XLVII. ARYTENOIDEUS OBLIQUUS is one which crosses in a more oblique direction, arising at the root of each arytenoid cartilage, and going obliquely upwards to the point of the opposite one. These two muscles draw the arytenoid cartilages together, and close the RIMA: frequently we find only one oblique muscle.

Crico-arytenoideus posticus. *Or. broad part of cricoid cart.* *In. back and outer point of arytenoid cart.*

XLVIII. The CRICO-ARYTENOIDEUS POSTICUS is a small pyramidal muscle, which arises broader from the back part of the cricoid cartilage, where the ring is broad and deep; and, going directly upwards, is implanted, with a narrow point, into the back of the arytenoid cartilage. This pair of muscles pulls the arytenoid cartilages directly backwards, and lengthens the slit of the glottis: perhaps they assist the former in closing it more neatly, and in producing more delicate modulations of the voice.

Crico-arytenoideus lateralis. *Or. side of cricoid cart.* *In. side of the base of the arytenoid cartilage.*

XLIX. The CRICO-ARYTENOIDEUS LATERALIS is one which comes from the sides of the cricoid cartilage where it lies under the wing of the thyroid, and being implanted into the sides of the arytenoid cartilages, near their roots, must pull these cartilages asunder, and (as the origin of the cricoid lies rather before their insertion in the arytenoid cartilages) it must also slacken the lips of the slit; for the lips of the slit are formed by two cords, which go within the covering membrane, from the tip of each cartilage to the back of the thyroid cartilage, and the crico-arytenoideus posticus must stretch these cords, and the crico-arytenoideus lateralis must relax them.

Thyro-arytenoideus. *Or. back and under part of thyroid cart.* *In. nearly the middle of the ary. cartilage.*

L. The THYRO-ARYTENOIDEUS is a muscle very like the last one, and assists it. It arises not from the cricoid cartilage, but from the back surface of the wing of the thyroid, from the hollow of its wing, or where it covers the cricoid; is implanted into the fore part of the arytenoid cartilage, and by pulling the cartilage forward and sideways, directly slackens the ligaments, and widens the glottis.

There is another muscle, the THYRO-EPIGLOTTIDEUS. It is composed of a number of fibres, which run from the concavity of the thyroid cartilage to the side of the epiglottis; it has been divided by Albinus into major and minor, but this we cannot expect to find always, as it is only in particular bodies that we see fibres running from the thyroid cartilage to the epiglottis. Along with this muscle may be classed the set of fibres which are seen sometimes running from the arytenoid cartilage to the epiglottis, and called *aryteno-epiglottideus.**

These are all the muscles which belong to the larynx; and in our arrangement the muscles of the PALATE and PHARYNX come next in order.

When a morsel is to be thrown down into the œsophagus, or tube which leads to the stomach, the VELUM PALATI, or curtain of the palate, is drawn upwards; the opening of the throat is dilated; the morsel is received; then the curtain of the palate falls down again. The arch of the throat is contracted, the bag of the pharynx is compressed by its own muscles; and the food is forced downwards into the stomach.

LI. The AZYGOS UVULÆ.—The VELUM PENDULUM PALATI is that pendulous curtain which we see hanging in the back part of the mouth, in a line with the side circles of the throat; and the uvula is a small pap, or point of flesh, in the centre of that curtain. The AZYGOS UVULÆ, or single muscle of the uvula, is a small slip of straight fibres, which goes directly down to the uvula in the centre of the curtain. It arises from the peak, or backmost sharp point of the palate bones, and pulls the uvula, or pap of the throat, directly upwards, removing it out of the way of the morsel which is to pass.

Azygos uvulæ.

Or. posterior extremity of palatine suture.
In. point of the uvula.

* There is in Albinus a second set of fibres, which he calls thyro-arytenoideus alter, arising from the inner and upper part of the thyroid cartilage, and inserted into the arytenoid cartilage just above the insertion of the crico-arytenoideus lateralis; this muscle must have much the same action as the other.

Levator palati. *Or.* extremity of pars petrosa, and Eustachian tube. *In.* the velum palati.

LII. LEVATOR PALATI MOLLIS arises from the point of the *os petrosum*, and from the EUSTACHIAN tube, and also from the sphenoid bone.* These parts hang over the roof of the velum, and are much higher than it; so this muscle descends to the velum, and spreads out in it; and its office is to pull up the velum, to remove it from being in the way of the morsel which is about to pass, and to lay the curtain back at the same time, so as to be a valve for the nostrils, and for the mouth of the Eustachian tube, hindering the food or drink from entering into these passages.

Circumflexus palati. *Or.* 1. spin. process of sphenoid. 2. Eustachian tube. 3. root of intern. pterygoid process. *In.* runs through the hook inserted into the velum palati.

LIII. The CIRCUMFLEXUS PALATI †, and the constrictor isthmi faucium, have a very different use. The circumflexus palati is named from its fibres passing over, or rather under the hook of the PTERYGOID process; the muscle arises along with the levator palati, (*i. e.*) from the sphenoid bone at its spinous process; and from the beginning of the Eustachian tube, it runs down along the tube, in the hollow betwixt the pterygoid processes; it then becomes tendinous, turns under the hook of the internal pterygoid process, and mounts again to the side of the velum. Now the levator and circumflexus arise from the same points; but the levator goes directly downwards into the velum, and so is useful in lifting it up. The circumflexus goes round the hook, runs on it as on a pulley, turns upwards again, and so it pulls down the palate, and stretches it, and thence

* From the Eustachian tube, it was named SALPINGO-STAPHILINUS; from the sphenoid bone, SPHENO-STAPHILINUS; from the pterygoid process, PTERYGO-STAPHILINUS; from the petrous process, it was named PETRO-SALPINGO-STAPHILINUS; as if there were no science but where there were hard names, and as if the chief mark of genius were enriching the hardest names with all possible combinations and contortions of them.

† This also has got a tolerable assortment of hard names, as CIRCUMFLEXUS PALATI, TENSOR PALATI, PALATO-SALPINGEUS, STAPHILINUS EXTERNUS, SPHENO-SALPINGO-STAPHILINUS, MUSCULUS TUBÆ, VIZ. EUSTACHIANÆ NOVUS. PTERYGO-STAPHILINUS of Cowper, &c.

is very commonly named the TENSOR PALATI MOLLIS, or stretcher of the palate.*

Constrictor isthmi faucium. Or. side of the tongue near its root.

LIV. The CONSTRICTOR ISTHMI FAUCIUM arises from the very root of the tongue on each side, goes round the middle of the velum, and ends near the uvula.† This semicircle forms that first arch which presents itself upon looking into the mouth.

In. middle of the velum at the root of the uvula.

Palato-pharyngeus. Or. middle of the velum at the root of the uvula. In. edge of the upper and back part of the thyroid cartilage.

LV. The PALATO-PHARYNGEUS ‡ again forms a second arch behind the first; for it begins in the uvula or middle of the soft palate, goes round the entry of the fauces, and ends in the wing or edge of the thyroid cartilage; and as the first arched line (that formed by the constrictor) belonged to the root of the tongue, the second arched line belongs to the pharynx or gullet; and between them is lodged the amygdala. § The circumflexus palati makes the curtain of the palate tense, and pulls it downwards: the constrictor faucium helps to pull down the curtain, and raises the root of the tongue to meet it: the palato-pharyngeus farther contracts the arch of the fauces, which is almost shut upon the morsel now ready to be forced down into the stomach, by those muscles which compress the pharynx itself.

The PHARYNX, which is the opening of the gullet, that it may receive freely the morsel of food, is expanded into a large and capacious bag, which hangs from the basis of the skull, is chiefly attached to the occipital bone, the pterygoid processes, and the back parts of either jaw-bone. The œsophagus again is the tube which conveys the food down into the stomach, and this bag of the pharynx is the expanded or trumpet-like end of it; or it may be com-

* Some of its posterior fibres mix with the constrictor pharyngis superior and palato-pharyngeus.

† Named GLOSSO-STAPHILINUS, from its origin in the tongue, and insertion into the UVULA.

‡ The SALPINGO-PHARYNGEUS of Albinus is no more than that part of the palato-pharyngeus which arises from the mouth of the Eustachian tube.

§ In its passage down its fibres are fixed with the stylo-pharyngeus, and in its insertion they are mingled with the inferior constrictors.

pared with the mouth of a funnel. Towards the mouth, the pharynx is bounded by the root of the tongue, and by the arches of the throat; behind, it lies flat and smooth along the bodies of the vertebræ; before, it is protected, and in some degree surrounded, by the great cartilages of the larynx; the horns of the os hyoides embrace its sides, and it is covered with flat muscular fibres, which, arising from the os hyoides and cartilages of the throat, go round the pharynx in fair and regular order, and are named its constrictors, because they embrace it closely, and their contractions force down the food.

Stylo-pharyngeus. *Or.* root of the styloid process. *In.* side of pharynx and back part of thyroid cartilage.

LVI. The STYLO-PHARYNGEUS arises from the root of the styloid process. It is a long, slender, and beautiful muscle; it expands fleshy upon the side of the pharynx; extends so far as to take a hold upon the edge of the thyroid cartilage; it lifts the pharynx up to receive the morsel, and then straightens and compresses the bag, to push the morsel down, and by its hold upon the thyroid cartilage it commands the larynx also, and the whole throat.

The pharynx being surrounded by many irregular points of bone, its circular fibres or constrictors have many irregular origins. The constrictor might fairly enough be explained as one muscle, but the irregular origins split the fibres of the muscle, and give occasion of dividing the constrictor into distinct parts; for one bundle arising from the occipital bone and os petrosum, from the tongue, the pterygoid process, and the two jaw-bones, is distinguished as one muscle, the constrictor superior.* Another bundle arising from the os hyoides is named the constrictor medius.† A third bundle, the lowest of the three, arising from the thyroid and cricoid cartilages, is named the con-

* These good opportunities of bestowing names have not been disregarded: this muscle has been named CEPHALO-PHARYNGEUS, PTERYGO-PHARYNGEUS, MYLO-PHARYNGEUS, GLOSSO-PHARYNGEUS.

† This one is named HYO-PHARYNGEUS, or SYNDESMO-PHARYNGEUS, from its origin in the cartilage also of the os hyoides.

strictor inferior.* And it is remarkable that the lower edges of the superior divisions are clasped and covered by the upper edges of that which is inferior; so that these muscles are like three funnels, one within the other.

LVII. The CONSTRICTOR SUPERIOR, arising from the basis of the skull, from the jaws, from the palate, and from the root of the tongue, surrounds the upper part of the pharynx; and it is not one circular muscle, but two muscles divided in the middle line behind, by a distinct rapha, or meeting of the opposite fibres.†

Constrictor superior. *Or.* 1. cuneiform process of the occipital b. 2. pterygoid process of the sphenoid. 3. alveolar process. *In.* into its fellow.

LVIII. The CONSTRICTOR MEDIUS rises chiefly from the round point in which the os hyoides terminates; it also arises from the cartilage of the os hyoides (*i. e.*) where the horns are joined to the body. The tip of the horn being the most prominent point, and the centre of this muscle, it goes upwards and downwards, so as to have something of the lozenge-like shape; it lies over the upper constrictor like a second layer; its uppermost peak, or pointed part, touches the occipital bone, and its lower point is hidden by the next muscle.

Constrictor medius. *Or.* appendix, cornu, and lig. of os hyoides. *In.* 1. cuneiform process of occip. bone, 2. into its fellow.

LIX. The CONSTRICTOR INFERIOR arises partly from the thyroid and partly from the cricoid cartilage; and it again goes also obliquely, so as to overlap or cover the lower part of the constrictor medius. This, like the other two constrictors, meets its fellow in a tendinous middle line; and so the morsel admitted into the pharynx by the dilatation of its arches, is pushed down into the œsophagus by the forces of these constrictores pharyngis, assisted by its styloid muscles.

Constrictor inferior. *Or.* sides of thyroid and cricoid cart. *In.* into its fellow.

The ŒSOPHAGUS is merely the continuation of the same tube. It lies flat upon the back-bone, and it is covered in its whole length by a muscular

* This, of course, is named THYRO-PHARYNGEUS, and CRICO-PHARYNGEUS.

† It is connected with the buccinator, the root of the tongue, and palate.

coat, which is formed, not like this of the pharynx, of circular fibres only, but of fibres running according to its length chiefly. And this muscle, surrounding the membraneous tube of the œsophagus, like a sheath, is named (LX.) VAGINALIS GULÆ.

MUSCLES OF THE TONGUE.

The muscles of the tongue are bundles of fibres, which come from the os hyoides, the chin, and the styloid process. Their thickness constitutes the chief bulk of the tongue. Their actions perform all its motions.

Hyo-glossus. *Or.* 1. base, 2. cornu, 3. appendix of os hyoides. *In.* tongue.

LXI. The HYO-GLOSSUS is a comprehensive name for all those which arise from the os hyoides. The muscles from the os hyoides go off in three fasciculi, and were once reckoned as distinct muscles. That portion which arises from the basis of the os hyoides was called BASIO-GLOSSUS; that which arises from the cartilaginous joining of the body and horn was called CHONDRO-GLOSSUS; and that which arises from the horn itself was named CERATO-GLOSSUS; or the terms were all bundled together in the perplexed names of BASIO-CHONDRO-CERATO-GLOSSUS.

The hyo-glossus, then, is all that muscular flesh which arises from the whole length of the os hyoides, and which, by the changing form of the bone in its basis, cartilage, and horn, has a slight mark of division, but which lie all in one plain, and need not have distinct names.

Genio-hyo-glossus. *Or.* process behind the symph. of lower jaw. *In.* 1. tip, middle, and root of the tongue, 2. base of os hyoides.

LXII. The GENIO-HYO-GLOSSUS arises from the rough tubercle behind the symphysis of the chin. It has a very narrow or pointed origin; it spreads out fan-like, as it goes towards the tongue and base of the os hyoides; and it spreads with radii, upwards and backwards, making the chief part of the substance of the tongue.

Lingualis. *Or.* root of the tongue. *In.* tip of the tongue.

LXIII. The LINGUALIS is an irregular bundle of fibres, which runs according to the length of the tongue; it lies betwixt the genio-hyo-glossus and the hyo-glossus, and as it is in the centre, and uncon-

nected with any bone, it is named lingualis, as arising in the tongue itself.

LXIV. The STYLO-GLOSSUS arises from the styloid process of the temporal bone, and from a ligament that connects that process to the angle of the jaw; and it is inserted into the root of the tongue, being insensibly lost on the side and tip of the tongue.

Or. styloid pro. and lig. inter max. et process styloid. *In.* side and tip of tongue.

The genio-hyo-glossi muscles form by far the larger part of the tongue, and lie in the very centre. They go through the whole length, (*i. e.*) from the root to the tip of the tongue; and from the radiated form of their fibres they perform every possible motion; whence this was named by Winslow, musculus POLYCHRESTUS, for its rays proceed from one point or centre, and those which go to the point of the tongue pull the tongue backwards into the mouth. Those which go backwards thrust the tongue out of the mouth. The middle fibres acting, make the back of the tongue hollow, while the tip and the root of the tongue both rise.

The hyo-glossi muscles lie on either side of the genio-hyoidei, and make up the sides of the tongue; and their chief action would seem to be this, that the hyo-glossus muscle of either side acting, the edges of the tongue would be pulled downwards, and the back rounded; the opposite of which motion is from the genio-hyoidei acting, by which the middle of the tongue is made into a groove, the edges rising, and the centre being depressed. Lastly, The stylo-glossus is plainly intended for drawing the tongue deep into the mouth, particularly affecting the point of the tongue.

OF THE MUSCLES OF THE ARM,

INCLUDING THE MUSCLES OF THE SCAPULA, ARM, FORE-ARM, AND HAND.

MUSCLES OF THE SCAPULA.

THE great peculiarity of the arm is the manner of its connection with the breast, to which it is fixed

by the slight ligaments of the clavicle only: but its union to the body is secured by its strong and numerous muscles, by which indeed it may be said both to be fixed and moved. Though it were perhaps more regular to describe first the muscles of the trunk, it will be more easy and natural to describe first the broad muscles belonging to the scapula, which cover almost the whole trunk, and hide its proper muscles, viz. those which move the ribs and spine. For the muscles which move the scapula lie upon the trunk; those which move the arm lie upon the scapula; those which move the fore-arm lie upon the arm; and those for moving the hand and fingers lie upon the fore-arm. The leg requires but one chief motion, viz. backwards and forwards, flexion and extension. It has no other motions than those of the thigh and of the knee; but the arm requires an easy and circular motion, and its joints are multiplied: for it has the wrist turning round; it has the elbow for hinge-like motions; it has the shoulder-joint upon which the arm rolls; and to assist all these, the scapula, which is the centre of all these motions, is itself moveable; after a certain point of elevation, all the motion in raising the arm is performed, not by the motions of the shoulder-bone upon the scapula, but by the scapula upon the trunk. For whenever the shoulder-bone rises to the horizontal direction, it is checked by the acromion, which hangs over it; and if the arm is to be raised higher still, the scapula must roll; it turns upon the point of the clavicle, and, in turning, it glides upon those muscles, which are like a cushion betwixt it and the trunk.

The muscles which move the scapula come from the breast to move it forwards; from the neck, to move it upwards; from the spines of the vertebræ, to move it backwards; and from the side, that is, from the ribs, to move it downwards.

Trapezius. LXV. The TRAPEZIUS is named from its lozenge form; or is often named CUCULARIS, from its resembling the monk's cowl, hanging back upon the neck. It is one of the most beautiful muscles in the

body; and the two muscles together cover all the shoulders and neck, with a lozenge-like form, with neat and sharp points, extending from the tip of one shoulder to the tip of the other, and from the nape of the neck quite down to the loins. It arises from *Or.* 1. transverse ridge of occip. b. the most pointed part of the occipital bone, and along the transverse spine quite to the mastoid process, by a thin membraneous tendon; from this point, all down the neck, it has no hold of the vertebræ, but arises from its fellow in a strong tendon, 2. ligament. nuchæ. which, extending like a bow-string down the neck, over the arch of the neck, and not touching the vertebræ, till it comes down to the top of the back, is named LIGAMENTUM NUCHÆ. The tendon begins 3. the two last vert. of neck, again to take hold of the spines of the two last vertebræ of the neck, and arises from all the spinous 4. all the spin. processes of dorsal vert. processes of the back, downwards; from this long origin its fibres converge towards the tip of the shoulder: it also comes a little forward over the side of the neck.

It is implanted into more than one third of the *In.* 1. the clavicle. clavicle nearest the shoulder; into the tip of the 2. Acromion. acromion; into the whole length of the spine of the 3. spine of scapula. scapula, from which the acromion rises; and its fibres arising from along the neck and back, and converging almost into a point, must have various effects, according to the different fibres which act: for those which come downwards must raise the scapula; those which come from the middle of the back must carry it directly backwards; those which come from the lower part of the back must depress it; and those different fibres acting in succession, must make the scapula roll. The trapezius is a muscle which moves the scapula, but it must be also occasionally a muscle of the head, pulling the head backwards, and bending the neck. It is also a powerful muscle of respiration, as may be seen under the head of Respiration.

LXVI. LEVATOR SCAPULÆ, named also LEVATOR Levator scapulæ. PROPRIUS ANGULARIS, is a small thin slip of flesh, which arises from the four or five uppermost vertebræ *Or.* trans. pro. of 4 or 5 upper cervical vert. of the neck, at their transverse processes, by three or four and sometimes five distinct heads. The heads

join to form a thin and flat stripe of muscle, about three inches in breadth, which is fixed by a flat thin tendon to the upper corner of the scapula, to pull it upwards, as in shrugging the shoulders; whence it is named MUSCULUS PATIENTIÆ.

In. upper angle of scapula.

Rhomboideus major. *Or.* spinous pro. of 4 sup. dorsal vert. *In.* nearly the whole of base of scap. below the spine.

LXVII. and LXVIII. The RHOMBOID MUSCLE stretches flat, neat, and of a square form, betwixt the spine and the whole line of the base of the scapula. One part arises from the three lower spinous processes of the neck, and is implanted into the base of the scapula higher than the rising of the spine of the scapula; another portion arises from the spinous processes of the first four vertebræ of the back, runs exactly in the same plane with the other into the base of the scapula below the spine.* The part arising from the three vertebræ of the neck is slightly divided from that which arises from the four vertebræ of the back, though not distinctly, and often not at all. I would reckon this but one muscle, but it has been commonly distinguished into (LXVII.) the RHOMBOIDEUS MINOR, the uppermost portion, and (LXVIII.) the RHOMBOIDEUS MAJOR, the lower portion. These are seen after raising the trapezius; and the uses of the trapezius, levator scapulæ, and rhomboideus, are to raise the scapula or to carry it backwards. The muscles which move the scapula downwards and forwards, viz. the pectoralis minor and the serratus major anticus, lie upon the fore part of the breast.

Rhomboideus minor. *Or.* spinous pro. of 3 last cervical vert. *In.* base of scap. opposite the spine.

Serratus magnus anticus.

LXIX. The SERRATUS MAGNUS ANTICUS lies upon the side of the chest arising from the ribs; and as the ribs have interstices betwixt them, every muscle arising from the ribs arises by distinct portions from each rib: all such distinct and pointed slips are named digitations, tongues, or sometimes serræ, from their resembling the teeth of a saw: and every muscle arising from the ribs must be a serrated muscle. The serratus magnus anticus is that great and broad muscle, the chief part of which lies under the scapula; and nothing of which is seen but the

* We frequently indeed almost find that the rhomboideus major takes also an origin from the 7th cervical vertebra: it is so expressed in Albinus.

fleshy tongues, by which it arises from the sides of the ribs. It is all fleshy, and is of a considerable breadth and strength: it arises from all the true ribs, (it sometimes misses the first rib) and from three of the false ribs: its indigitations, of course, spread all over the side of the thorax like a fan; its upper indigitations lie under the pectoralis major, and its lower indigitations are mixed with the beginning of the external oblique muscle of the abdomen; its middle indigitations are seen spreading upon the sides of the thorax: it lies thick and fleshy under the scapula, and is a part of that cushion on which the scapula glides: its fibres converge towards a narrower insertion; and the muscle ends thick and fleshy in the whole length of that line which we call the basis of the scapula, and is as it were folded round it; so that this muscle, which comes from before, is implanted along with the rhomboideus, which comes from behind.

Or. from the ribs. From the 2d to the 9th.

In. the base of the scapula.

One operation of this muscle is upon the scapula; when the whole acts, it pulls the scapula downwards and forwards; when only the lower portions act, it pulls the lower angle of the scapula forwards, by which the scapula rolls, and the tip of the shoulder is raised; when the upper part acts in conjunction with the little pectoral muscle, the tip of the shoulder is fixed and pulled towards the chest, and the lower corner of the scapula rolls backwards. But its most important action is in excited respiration, when its insertion is converted into its origin, and the scapula being fixed, it expands the ribs, and performs inspiration.

LXX. The PECTORALIS MINOR lies under the pectoralis major, close upon the ribs; and as it arises upon the third, fourth, and fifth ribs, it sometimes takes its origin from the second, third, and fourth ribs, and sometimes only from the third and fourth; it also is a serrated muscle, and was named serratus minor anticus: its three digitations are very thick and fleshy; and soon converge so as to form a small, but thick and fleshy muscle, which, terminating in a point, is inserted into the very apex of the coracoid

Pectoralis minor.

Or. 3d, 4th, and 5th rib.

In. Coracoid process of scapula.

process: by pulling the coracoid process forwards and downwards, it will roll the shoulder.

Subclavius.

LXXI. The SUBCLAVIAN MUSCLE is another concealed muscle of the scapula; for the clavicle is just the hinge upon which the scapula moves, and the subclavian muscle arises by a flat tendon from the cartilage of the first rib; it becomes flat and fleshy, and lies along betwixt the clavicle and the first rib, covered with a very firm fascia; it arises at a single point of the rib, flat and tendinous, but it is inserted into a great length of the clavicle; beginning about two inches from the sternum, and being inserted all along the clavicle, quite out to where it is joined to the acromion process, its chief use (since the rib is immoveable) must surely be to pull the clavicle, and consequently the shoulder downwards, and so to fix them.

Or. cartilage of the 1st rib.

In. into the lower edge of the clavicle.

The scapula is thus moved in every possible direction: upwards by the levator scapulæ and the trapezius; backwards by the rhomboideus, assisted by the middle portions of the trapezius; downwards and backwards by the lowest order of fibres in the trapezius; downwards and forwards by the serratus magnus anticus; directly downwards by the serratus, balanced by the trapezius, and assisted by the subclavius; and directly forwards by the pectoralis minor.

MUSCLES OF THE ARM;

VIZ. THOSE MOVING THE OS HUMERI, OR ARM-BONE.

Pectoralis major.

Or. 1. sternal half of the clavicle. 2. all the edge of sternum.

LXXII. The PECTORALIS MAJOR is a large, thick, and fleshy muscle which covers all the breast. It arises from the half of the clavicle next the sternum; from all the edge of the sternum, the cartilaginous endings of the three lower true ribs.* Where it

* We frequently find slips running as distinct muscles from the 7th and 8th rib to the humerus; they have been remarked, in the Windmill-street dissecting-room, more frequently in Lascars and Negroes than in Europeans. In December 1814, a body was dissected, in which there was found on both sides a slip of fibres 18 inches long, extending from the 4th and 5th rib to the fascia, between the triceps and brachialis internus, and a distinct slip of tendon might be traced even to the inner condyle.

arises from the sternum, it is tendinous, and the fibres from the opposite muscle cross and mix, so as to make a sort of fascia covering the bone. It is fleshy where it arises from the ribs, and there it mixes with the external abdominal muscle. The fibres approach each other till they form a flat tendon about an inch in breadth; and as the fibres approach each other, they cross in such a way, that the lower edge of the muscle forms the upper edge of the tendon, which is still flat, but twisted; its implantation is into the edge, if I may call it so, of the groove or rut of the biceps tendon. That part which arises from the clavicle is a little separated from that which arises from the sternum; a fatty line makes the distinction; and they are sometimes described as two parts: it is those two bundles chiefly which cross each other to make the plaited appearance. The pectoralis, among others, has been made a muscle of respiration.*

3. cartilages of 5th, 6th, and 7th ribs.

In. outside of bicipital groove of humerus.

LXXIII. The LATISSIMUS DORSI is the broadest, not only of the back, but perhaps of the whole body. It is a beautiful muscle, covering all the lower part of the back and loins, and reaching to the arm, to be the antagonist to the pectoral muscle. It arises by a broad, flat, and glistening tendon, which covers all the loins, and which is in some degree the root of other muscles, especially of the longissimus dorsi. This broad silvery tendon begins exactly in the middle of the back; it arises from the lower vertebræ of the loins, from the spines and knobs of the back of the sacrum, and from the back part of the circle of the os ilium; this last is the only part that is fleshy. The flat tendon gradually passes into a flat and regular muscle, which wraps round the side of the body, and as it lies over the corner of the scapula, it

Latissimus dorsi.

Or. 1. poster. part of the os ilii, 2. all the spinous pro. of sacrum and lumbar. vert. 3. spines of six or seven

* Haller tells us, that when, at any time, he had rheumatism in this muscle, his breathing was checked: and when he had difficult breathing, he found great relief by fixing his hands, raising the shoulders, and acting with the pectoral muscles. It seems confirmed by these facts, that asthmatics take this posture; women in labour fix their arms, by resting upon the arms of their chair; those who play on wind instruments raise the shoulders in straining.

inf. dorsal vert. & three inf. ribs; sometimes angle of the scapula.

sometimes receives a small fleshy bundle from it; and as it passes over the four lower ribs, it has some tendinous slips sent into it, by which it is attached to the ribs. Its fibres converge: for the lower ones ascend; the upper ones go directly across. And these different orders not only meet to form this flat tendon, but they cross each other, like those of the pectoral muscle: here also the tendon is twisted, and the upper edge of the muscle forms the lower edge of the flat tendon; which, passing into the axilla, turns under the arm-bone, and is implanted into it, on the inner edge of the bicipital groove; so the tendons of the pectoralis and latissimus meet each other; they, in fact, join face to face, as if the one tendon ended directly in the other; and both united, make a sort of lining for the groove, or a tendinous sheath, for the long tendon of the biceps to run on.

In. inner edge of bicipital groove of the humerus.

These two muscles form the axilla or arm-pit; and although each has its peculiar offices, their chief operation is when they coincide in one action; and that action is exceedingly powerful, both by the great strength of either muscle, and by their being implanted into the arm-bone, four inches below its head. The pectoralis major is for pulling the arm forwards, as in laying the arms across the breast, or in carrying loads in the arms; and it forms the border of the axilla before. The latissimus dorsi has a wider range; when the arm is raised, it brings it downwards as in striking with a hammer, or downwards and backwards, as in striking with the elbow, or in rolling the arm inwards and backwards, as in turning the palm of the hand behind the back, whence it has the obscene name of MUSCULUS SCALPTOR ANI, OR TERSOR ANI; and it forms the back edge of the axilla. The edges of these two muscles receive the pressure of crutches, and defend the vessels and nerves; when both muscles act, the arm is pressed directly downwards, as in rising from our seat, or in holding a bundle under the arm; or when the arm is fixed, these muscles raise the body as in the example just mentioned, of rising from our seat, or in walking

with a short stick, or in raising ourselves by our hands over a high beam.

LXXIV. The DELTOIDES is the first of those muscles which arise from the scapula, to be inserted into the shoulder-bone. It is named deltoid muscle, from its resembling the letter Δ of the Greeks; it is thick and fleshy, and covers the top of the shoulder, filling up the space betwixt the acromion process and the shoulder-bone; it arises from all that part of the clavicle which is not occupied by the pectoralis muscle, and is separated from it only by a fatty line; it arises again in another bundle, from the point of the acromion process, and this middle bundle is also insulated by a fatty line on either side of it. The third bundle arises from the spine of the scapula, behind the acromion process, and which is also attached to the base by a strong ligamentous fascia, which covers the infra spinatus muscle. And thus the muscle has three converging heads, viz. a head from the outer end of the clavicle, a head from the acromion, or tip of the shoulder, a head from the ridge of the spine, each divided from the other by a fatty line.* These heads or bundles of fibres, meeting about one third down the humerus, form a short, flat, and strong tendon, which grasps or almost surrounds the shoulder-bone.

Deltoides.

Or. 1. outer third of clavicle,

2 acromion,

3. spine and part of the base of scapula.

In. rough ridge on the fore part of the humerus.

These three distinct heads must be observed in speaking of the use of the muscle; for though the chief use of the muscle be to raise the arm, this is not the use of it in all circumstances; for the outer and inner heads, lying by the side of the shoulder-bone, and below the joint, do, when the arm is lying flat by the side, assist the pectoral and latissimus dorsi muscles in drawing it close to the side. But when the middle bundle raises the arm, in proportion as the middle bundle raises the arm, it loses its power; and in proportion as it loses of its power, the side portions having come into a new direction, begin to

* Albinus has distinguished it into seven fasciculi or bundles; a very superfluous accuracy.

help; nay, when the arm is raised to a certain point, more power is still required, and the clavicular part of the pectoral muscle also comes to assist. It is in this succession, that the several bundles of fibres act; for if they began all at once to act, the arm should rather be bound down by the lateral portions, than raised by the middle one. It is still more surprising that authors have neglected the great and obvious use of these lateral portions, since they are the most powerful rotators of the arm, *e. g.* the guards in fencing are performed chiefly through the operation of these portions of the deltoid muscle.

Coraco-brachialis.

LXXV. CORACO-BRACHIALIS.—The coraco-brachialis, so named from its origin and insertion, is a long and rather slender muscle.

Or. fore part of coracoid process.

In. inner ridge of humerus near the middle.

It arises from the coracoid process of the scapula, along with the short head of the biceps muscle, and it is closely connected with this head, almost its whole length; it is small at its beginning; it grows gradually thicker as it descends; it is all fleshy, and is inserted by a very short tendon into the os humeri, nearly about its middle, betwixt the brachialis and the third head of the triceps. It is perforated by the external cutaneous nerve. This was observed by Casserius, an Italian anatomist; and the muscle is often named MUSCULUS PERFORATUS CASSERII.

Its action is very simple, to raise the arm obliquely forwards and upwards, and consequently to give a degree of rotation. It will also have a chief effect in pulling the arm towards the side of the body.

Supra Spinatus.

LXXVI. The SUPRA SPINATUS is so named from its occupying the hollow of the scapula above the spine.

Or. dorsum, spine, base, and superior costa of the scapula.

In. upper part of the great tuberosity of humerus.

It arises from the back of the scapula reaching to the base, from the spine, and from the superior edge or costa; it is exceedingly thick and fleshy, filling up all the hollow between the spine and superior costa; and it is firmly enclosed in this triangular hollow, by a strong tendinous expansion which passes from the superior edge of the scapula to the ridge of the spine: it is consequently a muscle of a trian-

gular figure, thick and strong; it passes under the acromion, and degenerates into a tendon there, and going under the acromion, as under an arch, and over the ball of the humerus, it adheres to the capsule of the shoulder-joint, and is at last implanted by a broad strong tendon into the upper part of the great tuberosity on the head of the bone.

It is evidently designed for raising the humerus directly upwards, and by its attachment to the capsule, the capsule is drawn up when the arm is raised, so that though lax, it cannot be caught in the joint. It exactly performs the same motion with the middle part of the DELTOIDES, lies in the same direction with it, and assists it.

LXXVII. INFRA SPINATUS is like the former in all respects, of the same use, and assisting it. *Infra spinatus.*

This also is of a triangular shape, and is fully one half larger than the supra spinatus; and the supra spinatus arises from all the triangular cavity above the spine: this arises from almost all the triangular cavity below it.

It arises fleshy from all the back of the scapula below the spine, except that part giving origin to the teres major and minor, from the spine itself, and from all the base of the scapula, below the beginning of the spine, and also from the greater part of the lower costa of the scapula. It is very thick and strong, almost filling up the triangular cavity, and it is closed in, like the former, by a strong tendinous expansion; it begins to grow tendinous about its middle, but it continues also fleshy till it passes over the socket of the shoulder-joint: it also is connected with the capsular ligament, is inserted into the middle of the same tuberosity with the former, and has exactly the same uses, viz. preventing the capsule from being caught in the joint, and raising the arm upwards, and inclining it a little outwards, by a slight degree of rotation. And I do believe, that one great use of these two muscles is, when the arm is much extended backwards, to prevent the head of the humerus from starting out of its superficial socket. *Or. dorsum, spine, base, and inf. costa of scapula.* *In. middle part of the large tubercle of the humerus.*

LXXVIII. The TERES MINOR is a third muscle which co-operates with these. This and another are so named from their appearance, not from their shape, for they seem round when superficially dissected, because then their edges only are seen; but when fully dissected from the other muscles, they are rather flat. The teres minor is a small, fleshy muscle; it arises from the angle and all the lower edge of the scapula: it is like the infra spinatus; it becomes early tendinous; but the tendon is accompanied with fleshy fibres from below; its flat tendon, in passing over the joint, is attached to the capsule, and is finally inserted into the great tuberosity of the shoulder-bone, so that it must have exactly the same uses as the two former muscles. It is separated from the infra spinatus by that tendinous expansion with which the latter is covered; it looks like a part of the same muscle in its origin, where it lies upon the scapula; but is very distinct in its tendon. The supra spinatus, infra spinatus, and teres minor, raise and roll the arm outwards.

Teres minor. *Or.* edge of the inferior costa scapulæ. *In.* large tubercle of the humerus inferior to the last.

LXXIX. The TERES MAJOR is in shape like the former, lies lower upon the edge of the scapula than the teres minor, and is thicker and longer than it.

Teres major.

It arises chiefly from the angle of the scapula; partly from the lower edge of the scapula, at its back part; it is connected with the TERES MINOR and INFRA SPINATUS. It is a large, thick, and flat muscle, and forms a flat strong tendon, which passes under the long head of the triceps; it passes under the os humeri; turns round it, and is inserted into the ridge, on the inner side of the groove, and gives some tendinous fibres to line the groove. In short, it accompanies the tendon of the latissimus dorsi, is inserted along with it, and may be considered as the congener of the latissimus dorsi; and the two tendons are inclosed in one common capsule, or sheath of cellular substance.

Or. inferior angle, and part of the inferior costa of the scapula. *In.* the inside of the groove for the long tendon of the biceps.

Its use, then, is evidently to draw the humerus downwards and backwards, and to perform the same rotation of the arms, which the latissimus dorsi does.

LXXX. The SUBSCAPULARIS lines all the concavity of the scapula like a cushion. It is like the surface of the scapula on which it lies, of a triangular shape; and from the convergence of all the fibres it is completely radiated or fan-like; it is very fleshy, thick, and strong; the radii are each minutely described by Albinus; but Sabatier says, with good sense, that he cannot distinguish them, so as to describe them accurately; and he might have added, that there was not the shadow of a motive for wasting time in so trivial an employment as counting the bundles. Subscapularis.

It arises from the two costæ, the base, and all the internal surface of the scapula. And indeed it is to favour this origin that the inner surface of the scapula is full of little risings and hollows, to every one of which the muscle adheres closely. Just under the coracoid process is the only part from whence it does not arise. That little space is filled up with cellular substance. *Or.* 1. the concave surface of the scapula, 2. the base, 3. inferior costa, 4. sup. costa.

Its alternately tendinous and fleshy fibres are so rooted in the scapula, and so attached to its risings and depressions, that it is difficultly cleaned away from the bone.

The tendon and upper edge of the muscle is almost continuous with the supra spinatus; but from the manner of its insertion, its effect is very opposite from that of the supra spinatus, for it goes round the os humeri to its insertion, and it is fixed to the lesser tuberosity, therefore it both pulls the arm backwards and downwards, and performs the rotation like the teres major and latissimus dorsi. It is also like all the other tendons, attached to the capsule, so as to prevent its being caught; and it is particularly useful by strengthening the shoulder-joint. *In.* interna tubercle of the humerus.

OF THE MOTIONS OF THE HUMERUS.

HAVING thus described all the muscles which move this bone, I shall review the order in which they are arranged, and mark their place and effects.

To distinguish clearly the function of each muscle, we have but to mark the point to which it is attached.

1. Those implanted above the head of the bone must raise the arm. Now the supra spinatus, infra spinatus, and teres minor, are implanted into the great tubercle, and raise the arm; and the deltoides is implanted in the same direction, and still lower, so that it performs the same action with a still greater degree of power.

2. There is implanted into the opposite or lower part of the head, the subscapularis, which, of course, draws the arm directly downwards and backwards.

3. There is implanted into the outer edge of the bicipital groove, the pectoralis major, and also the coraco-brachialis, which comes in the same direction; and these two pull the arm inwards, towards the side, and forwards.

4. There are inserted into the inside, or lower side of the groove, the latissimus dorsi and teres major, both of which pull the arm directly backwards, as they bend under the arm, to reach their insertion. They also roll the palm inwards and backwards. And it is easy to observe in what succession those muscles must act, to describe the circular and rotatory motions of the arm.

Joints are more strengthened by the origin and insertion of muscles around them, than by elastic ligaments, which yield or tear; whereas the muscles, having a living power, re-act against any separating force. They contract, or, in other words, they are strong in proportion to the violence that the joint suffers. Thus, in the shoulder the capsule is so lax, that there is a mechanical contrivance to prevent its being checked in the joint, and it is moreover so weak, that, independent of its yielding easily, it is also very easily torn; but these muscles surround the joint so fairly, that their strength and their tendinous connections with the head of the bone are more than a compensation for the looseness of its capsular ligament. Were not the muscles thus

closely attached, the shoulders would be very often displaced, the glenoid cavity is so superficial, and the capsule so lax; and surely it is for some such purpose, that the muscles are planted so closely round the head; for when they are implanted at a distance from the centre, as one muscle the deltoid is, or as the biceps and triceps of the arm, or the hamstrings, or tendo Achillis, the power is much increased. Here, in the muscles arising from the scapula, power is sacrificed to the firmness of the joint, and they are all implanted closely round the head of the bone.

The connection of the bones in this joint is in a manner formed by these muscles, for the supra spinatus, infra spinatus, teres major and minor, and the subscapularis, surround the joint very closely, cover the joint with their flat tendons, and so thicken the capsule, and increase its strength.

The muscles of the fore-arm are only four, the BICEPS and BRACHIALIS for bending, and the TRICEPS and ANCONÆUS for extending.

LXXXI. BICEPS BRACHII FLEXOR is universally named BICEPS, from its having two very distinct heads. It is an exceedingly thick and strong muscle, for when it contracts, we feel it almost like a hard firm ball upon the fore part of the arm, and at the upper and most conspicuous part of this ball is the union of the two heads. Biceps.

The larger and thicker head arises from the coracoid process, by a tendon which extends three inches along the fore part of the muscle, in the form of an aponeurosis, but at the back part the tendon is short, and the muscle is attached there to the fleshy belly of the coraco-brachialis. Or. 1. coracoid process, 2. glenoid cavity.

The second, or long head, arises from the edge of the glenoid cavity, at its upper part; it is exceedingly small and tendinous, and this long tendon runs down in its proper groove, till about the third part down the humerus the two heads meet. And though below this it is but one fleshy belly, yet here, as in

other muscles, the common division betwixt its two origins may be still observed.*

In. 1. fascia of the fore arm, 2. tubercle of the radius.

It is earlier tendinous at the fore part and outer side; the tendon here sends off that aponeurotic expansion which covers all the arm below, and encloses the muscles as in a sheath. The tendon, at first flat and large, becomes gradually smaller and rounder; and turns a little in its descent, so as to lay one flat edge to the radius, and another to the ulna; and it is at last implanted into that round tubercle, which is on the upper part of the radius, a little below its neck; but it has also an insertion into the fascia of the fore-arm.

The great use of the biceps is to bend the fore-arm with great strength. But as it is inserted into the tubercle of the radius, when the arm and hand are turned downwards, it, by acting, will pull them upwards, *i. e.* it will assist the supinators. Since both its heads are from the scapula, it will occasionally move the humerus, as well as the fore-arm.

Brachialis internus.

LXXXII. The BRACHIALIS INTERNUS lies immediately under the biceps, and is a very strong, fleshy muscle, for assisting the biceps in bending the arm. It is called BRACHIALIS, from its origin in the fore-arm, and INTERNUS, from its being within the biceps.

Or. the anterior flat surface of humerus.

It arises from two thirds of the os humeri at its fore part, by a sort of forked head; for it comes down from each side of the deltoid. It continues its attachment all the way down the fore part of the humerus to within an inch of the joint. It is very thick, fleshy, and strong; it is tendinous for about two inches in its fore part; and is inserted by a flat strong tendon into the coronoid process of the ulna.

In. coronoid process of ulna.

Other uses are ascribed to it, as the lifting up the capsule to prevent its being pinched. But the chief use of it is to bend the fore-arm. In a strong man, it is exceedingly thick, and its edge projects from under the edge of the biceps, and is seen in the lateral view.

* It is not uncommon to find a third head to this muscle, which takes an origin from the fore part of the humerus.

LXXXIII. TRICEPS EXTENSOR. — Upon the back part of the arm three muscles have been described: the extensor longus, the extensor brevis, and the brachialis externus; but there is, in fact, only one three-headed muscle. Triceps extensor.

The longest head of this muscle is in the middle. It arises by a flat tendon from an inch of the inferior edge or costa of the scapula, under the neck, and a little way from the glenoid cavity; and it is under this head that the tendon of the teres major passes to its insertion. *Or.* 1st head, neck of the scapula.

The second head is on the outside of the arm, and next in length to this. It arises from the arm-bone under the great tuber, and just below the insertion of the teres minor. The long and second heads meet about the middle of the humerus. 2d head, external ridge of the humerus.

The third, or internal head, is the shortest of all. It begins at the inner side of the humerus, just under the insertion of the teres major; and it arises from the inner part of the humerus, all the way down, and joins just where the second head joins (*i. e.* about the middle). All these heads still continue adhering to the humerus (as the brachialis does on the fore side), quite down to within an inch of the joint, and then a strong thick tendon is formed, by which it is implanted strongly in the projecting heel of the ulna, named olecranon, by which projection of the bone the muscle has great power, and the power is increased by an increased length of the process in dogs and other animals which run or bound. 3d head, internal ridge of the humerus. *In.* Olecranon.

The whole forms a very thick and powerful muscle, which covers and embraces all the back part of the arm; and its use is too simple to admit of any farther explanation, than just to say that it extends the hinge-joint of the elbow with great power; and that by its long head it may assist also to bend the arm-bone outwards and backwards.

LXXXIV. The ANCONÆUS is a small triangular muscle, placed on the back part of the elbow. It arises from the ridge and from the external condyle Anconæus. *Or.* ridge and outer condyle of

the humerus. of the humerus, by a thick, strong, and short tendon. From this it becomes fleshy, and after running about

In. flat surface on the back of the ulna. three inches obliquely backwards, it is inserted by its oblique fleshy fibres into the outer part of the ridge of the ulna.

It is manifestly designed for the extension of the fore-arm, and has only that one simple action.

THE FASCIA OF THE ARM.

Besides bones, there is also another source of attachment for muscles, that is, the tendinous expansions: for the expansions, which go on the surface like sheaths, also dive betwixt the muscles, and form septa, or partitions, from which their fibres arise.

One tendinous expansion begins from the clavicle and acromion process, or rather comes down from the neck: it is then strengthened by the tendon of the deltoid muscle; it descends, covering all the arm; and before it goes down over the fore-arm, it is again reinforced chiefly by the biceps, but also by the tendon of the triceps extensor. One remarkable process, or partition of this general fascia, is sent in from the sheath to be fixed to the outside of the humerus, all the way down to the ridge of the outer condyle. Another partition goes down, in like manner, to the inner condyle, along the ridge which leads to it; then the fascia, taking a firm hold on the condyles, is greatly strengthened about the elbow, and goes over the fore-arm, enclosing its muscles in a very firm and close sheath; and it sends partitions down among the several layers of muscles in the fore-arm, which gives each of them a firm hold.

The fore-arm is covered with this fascia, or strong tendinous web, which, like that which covers the temporal muscle, gives both origin and strength to the muscles which lie under it, which divides the several layers one from another. This fascia is said to proceed from the small tendon of the biceps muscle, though that were but a slender origin for so great a web of tendon, which not only covers the

surface of the muscles, but enters among their layers. This fascia really begins in the shoulder, and has an addition and an increase of strength from every point of bone; it is assisted by each tendon, because the tendons and fascia are of one nature over all the body, and its connection with the tendon of the biceps is quite of another kind from that which has been supposed. I would not allow that the biceps tendon expands into the fascia, but rather that the web receives the biceps tendon, which is implanted into it, and for this wise purpose, that when the fore-arm is to strike, or the hand to grasp, the biceps first moves, and by making the fascia tense, prepares the fore-arm for those violent actions which are to ensue. Thus, it may be defined, a web of thin but strong tendon, which covers all the muscles of the fore-arm, makes the surface before dissection firm and smooth, sends down partitions which are fixed into the ridges of the radius and ulna, enabling those bones to give a broader origin to the muscles, establishing a strong connection among the several layers, and making the dissection more difficult.

The fascia of the fore-arm is continued to the wrist, where it is strengthened by the annular ligament, and passes over the back of the hand even to the fingers.

The fascia of the fore-arm, and its relation to the tendon of the biceps flexor, is of much importance as a piece of surgical anatomy. It has to be particularly considered in very many cases, as in wounds of the fore-arm, abscesses forming under it; as in the inflammation which follows bleeding, and in the aneurism which is consequent on the wound of the brachial artery.

MUSCLES OF THE FORE-ARM, CARPUS, AND FINGERS.

The motions to be performed by the muscles which lie upon the fore-arm are these three; to roll the hand, to bend the wrist, to bend the fingers.

1. The turning of the hand, which is performed

by rolling the radius on the ulna, is named pronation and supination. When we turn the palm down, it is said to be prone; when we turn the palm upwards, it is supine. This is pronation and supination. The muscles which perform these motions are the PRONATORS and the SUPINATORS, and the motion itself is best exemplified in the turning a key in a lock, or in the guards of fencing, which are formed by a continual play of the radius upon the ulna, carrying the wrist round in the half circle. Now, all muscles which are inserted into the radius turn it or roll it. We have just seen that even the biceps does so. Therefore, when the student finds a muscle inserted into this bone, he knows by that mark that it is either a pronator or a supinator.

2. The wrist is called the CARPUS, and, therefore, those muscles which serve for bending or extending the wrist are the FLEXORS and EXTENSORS of the carpus.

3. The bending and extending of the fingers cannot be mistaken, and therefore the flexors and extensors of the fingers need not be explained.

These muscles are denominated from their uses chiefly; but if two muscles perform one motion, they may be distinguished by some accident of their situation or form. And thus, if there be two benders of the fingers, one above the other, they are named FLEXOR SUBLIMIS and FLEXOR PROFUNDUS, *i. e.* the superficial and deep flexors. If there be two flexors of the carpus, one is named FLEXOR RADIALIS CARPI, by its running along the radius, the other FLEXOR ULNARIS CARPI, from passing in the course of the ulna. And if there be two pronators, one may be distinguished PRONATOR TERES, from its round shape, the other PRONATOR QUADRATUS, from its square form. And this, I trust, will serve as a key to what is found to be a source of inextricable confusion.

It will be easy to make the origins and insertions still more simple than the names; for all the muscles arise from two points, and have but two uses.

This assertion shall be afterwards qualified with a

few exceptions; but at present it shall stand for the rule of our demonstration; for all the muscles arise from two points, the external and internal condyles. The internal condyle is the longer one, and gives most power: more power is required for bending, grasping, and turning the hand inwards; therefore all the muscles which bend the hand, all the muscles which bend the fingers, and the principal pronator, or that muscle which turns the palm downwards, arise from the internal condyle.

The external condyle is shorter; it gives less power; there is little resistance to opening the hand, and little power is required in extending the fingers; and so all the muscles which extend the wrist or the fingers, or roll the hand outwards to turn it supine, arise from the external condyle. So that when we hear a pronator or a flexor named, we know that the origin must be the internal condyle, and the insertion is expressed by the name. Thus a pronator radii goes to the radius; a flexor carpi goes to the wrist; a flexor digitorum goes to the fingers; and a flexor pollicis goes to the thumb: and they all issue from the inner condyle as from a centre.

And, again, when a supinator or extensor is named, we know where to look for it; for they also go out from one common point, the external condyle; and the supinator radii goes to the radius; the extensor carpi goes to the wrist; the extensor pollicis goes to the thumb; and the extensor indicis to the fore finger.

A kind of artificial memory of the muscles of the fore-arm may be had by arranging them in numbers; for example, if we take the biceps flexor as supinator in this instance, which it truly is, and the mass of the flexor muscles as one great pronator, for such is their conjoint operation, then the muscles go in threes thus: —

For the motion of the wrist, *three flexors*, the ulnaris, radialis, and medius, commonly called palmaris longus. — *Three extensors*, ulnaris, radialis longior, and brevior. — *Three pronators*, the teres,

quadratus, and the mass of flexor muscles. — *Three supinators*, the supinator longus, brevis, and biceps cubiti. There are *three extensors of the fingers*, extensor communis digitorum, extensor primi digiti, extensor minimi digiti. — *Three extensors of the thumb*, extensor primus, secundus, and tertius. — *Three flexors of the fingers and thumb*, flexor digitorum sublimis, flexor digitorum profundus, flexor pollicis longus. In the arrangement of the muscles of the fore-arm, it is correct to say that the flexors arise from the inner condyle, and the extensors from the outer condyle; but the supinators and pronators are better distinguished by their insertion: — thus, all muscles inserted into the radius turn the wrist, and thus the supinator longus, the supinator brevis, the pronator teres, the pronator quadratus, and the biceps, are employed in turning the hand.

MUSCLES INSERTED INTO THE RADIUS.

Supinator radii longus.

Or. ridge and outer condyle of the humerus.

LXXXV. SUPINATOR RADII LONGUS. This muscle forms the very edge of the fore-arm: it arises by many short tendinous fibres, from the ridge of the humerus, above the external condyle, which origin is fully two inches in length above the condyle. It also arises from the intermuscular membrane; and, as it lies on the very edge of the fore-arm, it runs betwixt the flexor and extensor radialis. It becomes thicker as it passes the joint of the humerus, and there gives a very peculiar form to the arm: it then becomes smaller, and forms a flat tendon, which is quite naked of flesh from the middle of the radius, or a little below, down to the wrist. This tendon becomes gradually smaller, till it reaches the wrist, where expanding a little, it is inserted into the lower head of the radius on its outer side.

Ix. lower head of the radius.

Its use is, perhaps, chiefly as a supinator, but it is placed just upon the edge of the arm; it stands as a sort of intermedium betwixt the two sets of muscles; it is fixed, indeed, rather upon the internal surface of the radius; but yet, when the supination

is complete, when the hand is rolled very much outward, it will become a pronator.

It is at once supinator and pronator, and, for a most evident reason, a flexor also of the fore-arm, since its origin is at least two inches up the humerus, above the joint of the elbow.

LXXXVI. The SUPINATOR BREVIS is an internal muscle, which forms, with the muscles of the thumb and of the fore finger, a kind of second layer; and this one lies concealed, as much as the pronator quadratus does, on the inner side of the fore-arm. It is a short muscle, but very thick and fleshy, and of great power. Supinator brevis.

It arises from the outer condyle of the os humeri, and from the edge of the ulna, and from the interosseous ligament: it is then lapped over the radius, and is inserted into its ridge; so that this supinator brevis is very directly opposed to the pronator teres, the insertion of the two muscles almost meeting on the edge of the radius. It is almost circumscribed to one use, that of preforming the rotation of the radius outwards; but perhaps it may also have some little effect in extending the ulna, and of assisting the anconaeus. *Or.* 1. ext. condyle of the humerus. 2. back of the ulna. *In.* ridge of the radius.

LXXXVII. The PRONATOR TERES RADII is of the outermost layer of muscles, is small and round; named pronator from its office of turning the radius, and teres from its shape, or rather to distinguish it from the pronator quadratus, which is a short square muscle, and which lies deep, being laid flat upon the naked bones. Pronator teres.

The pronator teres arises chiefly from the internal condyle of the humerus, at its lower and fore part. It has a second origin from the coronoid process of the ulna; these form two portions, betwixt which passes the radial nerve. The muscle thus formed is conical, is gradually smaller from above downwards, is chiefly fleshy, but is also a little tendinous, both at its origin and at its insertion; and stretches obliquely across the fore-arm, passing over the other *Or.* inner condyle and ridge of the ulna. *In.* near the middle of the radius.

muscles to be inserted in the outer ridge of the radius, about the middle of its length.

Its use is to turn the hand downwards, by turning the radius; and it will also, in strong actions, be brought to bend the fore-arm on the arm, or the reverse, when the fore-arm is fixed, and we are to raise the trunk by holding with the hands.

Pronator quadratus.

LXXXVIII. The PRONATOR QUADRATUS, so named from its shape and form, is one of the most simple in its action, since it serves but one direct purpose, viz. turning the radius upon the ulna.

It lies flat upon the interosseous ligament upon the fore part of the arm, about two inches above the wrist; it is nearly square, and is about three inches in length and breadth. Its fibres goes obliquely across, betwixt the radius and ulna. It arises from the edge of the ulna, adheres to the interosseous ligament, and goes to be implanted into the edge of the radius; it turns the radius upon the ulna. This muscle, and in some degree also the flexor pollicis, are the only muscles which do not come fairly under that arrangement by which I have endeavoured to explain the muscles of the fore-arm.

Or. edge of the ulna.
In. edge of the radius.

Palmaris longus.

LXXXIX. The PALMARIS LONGUS, FLEXOR CARPI MEDIUS, is a long thin muscle, which, although it seems to have another use in its expansion into the aponeurosis, yet is truly, by insertion into the annular ligament of the wrist, a flexor of the wrist, and, in some degree, a pronator of the radius.

It arises from the internal condyle of the os humeri, and is the first of five muscles, which have one common tendon going out, like radii, from one common centre, viz. the palmaris; the flexor radialis; the flexor ulnaris; the flexor digitorum sublimis; the flexor digitorum profundus.

Or. inner condyle, and fascia of the fore-arm.

The palmaris longus arises from the inner condyle of the os humeri, and also from the intermuscular tendon, which joins it with the flexor radialis and flexor digitorum sublimis, and from the internal surface of the common sheath. Its fleshy belly is but

two inches and a half or three inches in length; and its long slender tendon descends along the middle of the fore-arm to be inserted into the fore part of the annular ligament of the wrist, just under the root of the thumb. This tendon seems to give rise to the very strong thick aponeurosis of the palm of the hand, (under which all the muscles of the hand run, and which conceals the arch of blood-vessels, and protects them,) thence the muscle has its name. But it is a very common mistake to think, that because tendons are fixed to the sheaths, the sheaths are only productions of the tendons; whereas the sheaths do as truly arise from bones. The fascia, which the deltoides is thought to form, arises from the acromion and clavicle; and the fascia, which the biceps is thought to produce, arises from the condyles of the humerus; and that great sheath of tendon which is made tense by the musculus fascialis of the thigh, does not arise from that muscle, but comes down from the spine of the ilium, strengthened by expansions from the oblique muscles of the abdomen; in the present instance, we have the clearest proof of fascia being derived from some other source than the tendons, for sometimes the palmaris muscle is wanting, when still the tendinous expansion is found, and some pretend to say, that the expansion is wanting when the muscle is found. The aponeurosis, which covers the palm, is like the palm itself, of a triangular figure; it begins from the small tendon of the palmaris longus, and gradually expands, covering the palm down to the small ends of the metacarpal bones. Its fibres expand in form of rays; and towards the end there are cross bands which hold them together, and make them stronger; but it does not cover the two outer metacarpal bones, (the metacarpal of the fore finger, or of the little finger,) or it only covers them with a very thin expansion.

In. annular lig. and fascia palmaris.

Now this palmar expansion also sends down perpendicular divisions, which take hold on the edges of the metacarpal bones: and thus there being a perpendicular division to each edge of each meta-

carpal bone, there are eight in all, which form canals for the tendons of the fingers, and for the lumbricales muscles.*

Palmaris brevis. *Or. fascia palmaris. In. os pisiforme and the skin and fat of the palm.*

XC. The PALMARIS BREVIS is a thin flat cutaneous muscle, which arises properly from the edge of the palmar aponeurosis, near to the ligament of the wrist; whence it stretches across the hand in thin fasciculi of fibres, which are at last inserted into the os pisiforme, and into the skin and fat on the ulnar edge of the palm. This is the PALMARIS CUTANEUS of some authors, for which we can find no use, except of drawing in the skin of the hand, and perhaps making the palmar expansion tense.

Flexor carpi radialis.

XCI. The FLEXOR CARPI RADIALIS is a long thin muscle arising from the inner condyle, stretching along the middle of the fore-arm somewhat in the course of the radius, and is one of the five muscles which rise by one common tendon, and which are, for some way, tied together.

Or. inner condyle and fascia of the fore-arm.

It arises tendinous from the inner condyle; the tendon very short and thick. This tendon at its origin is split into many (seven) heads, which are interlaced with the heads of the sublimis, profundus, palmaris, &c.; consequently this muscle not only arises from the internal condyle, but also from the intermuscular partitions (as from that betwixt it and the sublimis): it forms a long tendon, which, becoming at last very small and round, runs under the annular ligament; it runs in a gutter peculiar to itself; but in this canal it is moveable, not fixed: it then expands a very little, and is inserted into the metacarpal bone of the fore finger, also touching that which supports the thumb.

In. metacarpal bone of the fore finger and first of the thumb.

Its use is chiefly to bend the wrist upon the radius. But when we consider its oblique direction, it will also be very evident that it must have some effect in

* There is great irregularity in this muscle; it is frequently wanting, and it is not uncommon to find two. We have found more than once, that the tendinous part of the muscle was next to the condyle, and the fleshy part connected with the fascia palmaris.

pronation; and this, like many of the muscles of the fore-arm, although designed for a different purpose, will also have some effect in bending the fore-arm at the elbow-joint.

XCII. The FLEXOR CARPI ULNARIS is a long muscle, much like the former; but as its course is along the radius, or upper edge of the fore-arm, this runs along the ulna or lower edge. *Flexor carpi ulnaris.*

It comes off tendinous from the inner condyle of the os humeri, by the common tendon of all the muscles; it has also, like the pronator teres, a second head, viz. from the olecranon process of the ulna, which arises fleshy, and the ulnar nerve perforates betwixt these heads. The flexor ulnaris passes all along the flat side of the ulna, betwixt the edge of the sublimis and the ridge of the bone: and here it has a third origin of oblique fibres, which come from the edge of the ulna, two thirds of its length. Its tendon begins early on its upper part, by which it has somewhat the form of a penniform muscle. It has still a fourth origin from the intermuscular partition, which stands betwixt it and the flexor sublimis; and is also attached to the internal surface of the common fascia of the arm. Its long tendon is at last inserted into the os pisiforme at its fore part, where it sends off a thin tendinous expansion to cover and strengthen the annular ligament; and also a thin expansion towards the side of the little finger to cover its muscles. *Or. 1. inner condyle, 2. olecranon, 3. the ridge of the ulna, 4. the interosseous lig. and 5. the fascia. In. os pisiforme.*

This is to balance the flexor radialis: acting together, they bend the wrist with great strength; and when this muscle combines in action with the extensor carpi ulnaris, they pull the edge of the hand sideways.

XCIII. The FLEXOR DIGITORUM COMMUNIS SUBLIMIS is named SUBLIMIS from being the more superficial of the two muscles; PERFORATUS, from its tendon being perforated by the tendon of that which lies immediately below. It lies betwixt the palmaris longus and flexor ulnaris: it is a large fleshy muscle; and *Flexor digitorum sublimis.*

not only its tendons, but its belly also, is divided into four fasciculi, corresponding with the fingers which it is to serve.

Or. 1. internal condyle, 2. coronoid pro. of the ulna, and 3. sharp ridge of the radius.

It arises from the internal condyle, along with the other four muscles; from the ligament of the elbow-joint; from the coronoid process of the ulna; and from the upper part of the radius, at the sharp ridge. By these origins it becomes very fleshy and thick; and, a little above the middle of the fore-arm, divides into four fleshy portions, each of which ends in a slender tendon. The tendons begin at the middle of the fore-arm, or near the division, but they continue to be joined to each other by fleshy fibres some way down: and indeed the fleshy fibres cease only when it is about to pass under the annular or transverse ligament of the wrist. At this place, a cellular stringy tissue connects the tendons with each other, and with the tendons of the profundus; but after they have passed under the ligament, they expand towards the fingers which they are to serve. They each begin to be extended and flattened, and to appear cleft; they pass by the edge of the metacarpal bones, and escape from under the palmar aponeurosis; and where it ends, viz. at the root of the fingers, a tendinous sheath begins, in which these tendons continue to be enclosed.

The tendons are fairly split just opposite to the top of the first phalanx; and it is at this point that the tendons of the deeper muscle pass through this splitting. The flattened tendon parts into two, and its opposite edges diverge; the back edges meet behind the tendons of the profundus, and form a kind of sheath for them to pass in; and then they proceed forward along the second phalanx, into the fore part of which they are implanted.

In. second phalanx of all the fingers.

This muscle is exceedingly strong: its chief office is to bend the second joint of the fingers upon the first, and the first upon the metacarpal bone. And in proportion to the number of joints that a muscle passes over, its offices must be more numerous; for this one not only moves the fingers on the metacar-

pus, but the hand upon the wrist, and even the fore-arm upon the arm.

XCIV. The FLEXOR DIGITORUM PROFUNDUS vel PERFORANS has so nearly the same origin, insertion, and use, that the description of the last is applicable to this muscle in almost every point. This is of a lower stratum of muscles; it lies deeper, and under the former, whence its name: and by this deeper situation it is excluded from any hold upon the tubercle of the humerus.

Flexor digitorum profundus.

It arises from the ulna, beginning at the coronoid process, and extending all along its internal surface, from the whole surface of the interosseous ligament, from the inner edge of the radius, and also, in some degree, from the intermuscular membrane, which separates this from the sublimis.

Or. 1. coronoid pro. 2. the ridge of the ulna, 3. interosseus ligament, and 4. edge of the radius.

This muscle is small, we may say compressed above, but it grows pretty strong and fleshy near the middle of the arm; it divides above the middle of the arm into four portions, corresponding with the four fingers; and it is about the middle of the arm that the tendons begin, and continue to receive muscular fibres from behind, all down to the ligament of the wrist: at the wrist these tendons are tied to each other, and to the tendons of the sublimis, by loose tendinous and cellular fibres. They diverge from each other, after passing under the annular ligament; and going along in the hollow of the bones, under the tendons of the sublimis, they first pass through the bridges formed by the palmar aponeurosis, then enter the sheaths of the fingers, and finally pass through the perforations of the sublimis, a little below the second joint of the fingers: at this place the perforating tendons are smaller and rounder for their easy passage, and after passing they again expand and become flat. They also, above this, appear themselves split in the middle without any evident purpose; they pass the second phalanx, and are fixed into the root of the third. And every thing that is said of the use of the sub-

In. 1st phalanx of all the fingers.

limis may be applied to this, only that its tendons go to the furthest joint.

Lumbricales.

XCV. LUMBRICALES.—I shall here describe, as a natural appendage of the profundus, the LUMBRICALES muscles, which are four small and round muscles, resembling the earth-worm in form and size; whence they have their name. They arise in the palm of the hand, from the tendons of the profundus, and are therefore under the sublimis, and under the palmar aponeurosis. They are small muscles, with long and very delicate tendons. Their fleshy bellies are about the length of the metacarpal bones, and their small tendons stretch over two joints, to reach the middle of the second phalanx. The first lumbricalis is larger than the second, and the two first larger than the two last.

Or. tendon of the flexor profundus.

In. middle of the second phalanx.

The first arises from the side of the tendon of the fore finger which is next to the radius; the others arise in the forks of the tendons; and though they rise more from that tendon which is next the ulna, yet they have attachments to both. Their tendons begin below the first joint of each finger; they run very slender along the first phalanx, and they gradually wind around the bone; so that though the muscles are in the palm of the hand, the tendons are implanted in the back parts of the fingers, and their final connection is not with the bending tendons of the sublimis and profundus, but with tendons of the extensor digitorum, and with the tendons of the external interossei muscles, with which they are united by tendinous threads.

Hence their use is very evident; they bend the first joint, and extend the second; they perform alternately either office; when the extensors act, they assist them by extending the second phalanx or joint: when the flexors act, and keep the first and second joint bended, the extending effect of these smaller muscles is prevented, and all their contraction must be directed so as to affect the first joint only, which they then bend.

They are chiefly useful in performing the quick short motions, and so they are named by Cowper the musculi fidicinales, as chiefly useful in playing upon musical instruments.

XCVI. The FLEXOR LONGUS POLLICIS is placed by the side of the sublimis, or perforatus, and lies under the supinator and flexor carpi radialis. It runs along the inner side of the radius, whence chiefly it arises. Flexor longus pollicis.

Its origin is from all the internal face of the radius downwards, from the place where the biceps is inserted, and from the interosseous ligament, all the length down to the origin of the pronator quadratus: nor does it even stop here; for the tendon continues to receive fleshy slips all the way down to the passage under the ligament of the wrist. It has also another head, which arises from the condyle of the humerus, and the fore part of the ulna; which head is tendinous, and joins that origin which comes from the radius. Or. inner surface of the radius, and inner condyle of the humerus. In. the last phalanx of the thumb.

The muscle becomes again tendinous, very high, *i. e.* above the middle of the arm; and its small tendon passes under the annular ligament, glides in the hollow of the os metacarpi pollicis, and separates the short flexor into two heads, passes betwixt the two sesamoid bones in the first joint of the thumb, and running in the tendinous sheath, it reaches at last the end of the farthest bone of the thumb, to be inserted into the very point of it.

There is sometimes sent off from the lower part of the muscle a small fleshy slip, which joins its tendons to the indicator tendon of the sublimis.

Its uses, we conjecture, are exactly as of those of the other flexors, to bend the last phalanx on the first, the first on the metacarpal bones, and occasionally the wrist upon the radius and ulna.

EXTENSORS.

The muscles which lie upon the outer side of the fore-arm, the supinators, and the extensors of the fingers and wrist, all arise from one point, the external

condyle of the humerus, and are all delivered in this list:

The EXTENSOR CARPI RADIALIS LONGIOR,
The EXTENSOR CARPI RADIALIS BREVIOR,
The EXTENSOR CARPI ULNARIS, — all extend the wrist.

The SUPINATOR LONGUS,
The SUPINATOR BREVIS, — turn the palm upwards.

The EXTENSOR COMMUNIS DIGITORUM, — extends all the fingers, and unfolds the hand.

The EXTENSOR PRIMI INTERNODII POLLICIS,
The EXTENSOR SECUNDI INTERNODII POLLICIS,
The EXTENSOR TERTII INTERNODII POLLICIS, — extend the several joints of the thumb.

The EXTENSOR PRIMI DIGITI vel INDICATOR, — extends the fore finger.

The EXTENSOR MINIMI DIGITI vel AURICULARIS, — extends the little finger.

All these muscles arise from one point, the external condyle. They all roll the radius outwards, or extend the wrist, or extend the fingers. As the muscles which are flexors need more fibres, and greater strength, they arise from the internal condyle, which is the larger: they lie in a deep hollow, for the bones of the fore-arm are bent to receive them, and they form a very thick fleshy cushion: but the extensors, requiring less power, arise from the shorter process of the outer condyle, are on the convex side of the arm, and are thin, having few fibres; for though there is a large mass of flesh on the inner side of the arm, forming two big flexors of the fingers, there is only a thin layer on the outer side of the arm, forming one flat and weak extensor.

Extensor carpi radialis longior.

XCVII. The EXTENSOR CARPI RADIALIS LONGIOR has the additional name of longior or primus, to distinguish it from the next. It is almost entirely covered with the last muscle, the supinator.

Or. ridge and outer condyle of the humerus.

It arises from the ridge of the humerus above the external condyle, and just under the origin of the supinator; it descends all along the back of the

radius; and after having become a thick fleshy belly, it degenerates, a little lower than the middle of the radius, into a thin flat tendon, which becomes slender and smaller as it descends; and turning a little more towards the back of the radius, it then passes over the wrist, and goes along with the tendon of the extensor, under the annular ligament, passing in a groove of the radius; at last it is inserted into the root of the metacarpal bone of the fore finger, in that edge next the thumb. *In. metacarpal bone of the fore finger.*

It is chiefly an extensor of the wrist: in pronation, it pulls the wrist directly backwards; in supination, it moves the hand sideways. It is also a pronator, when the hand is turned back to the greatest degree; and from its origin, high upon the arm bone, it is also a flexor of the fore-arm.

XCVIII. Extensor carpi radialis brevior.— This muscle is almost the same in description, name, and use, with the former. It arises from the external condyle; and here a common tendon for many muscles is formed, just as in the internal condyle; for from this point arise the extensor carpi radialis brevior, extensor digitorum, extensor minimi digiti, extensor carpi ulnaris. *Extensor carpi radialis brevior.*

The extensor carpi radialis brevior arises from the outer condyle of the humerus, by the common tendon; it also arises from the aponeurosis, which lies betwixt the extensor digitorum and this; it grows a pretty large, fleshy body, and begins, like the last, to be tendinous below the middle of the radius; so that this muscle continues fleshy lower than the last one, and its tendon is also much larger and thicker; it runs under the annular ligament, in the same channel with the extensor longior; it expands a little before its insertion, which is into the back part of the metacarpal bone of the middle finger, a little towards that edge which is next the radius: some little fibres pass from this tendon to the metacarpal bone of the fore finger. *Or. outer condyle of the humerus, and fascia of the fore-arm.* *In. metacarpal bone of the middle finger.*

All that was said concerning the extensor longus may be said of this; for all the three last muscles lie

so ambiguously on the edge of the arm, that though they are regularly supinators and extensors, they become pronators and flexors in certain positions of the hand.

Extensor carpi ulnaris.

XCIX. Extensor carpi ulnaris. — By the name merely of this muscle we know its extent and course, its origin, insertion, and use.

Or. 1. outer condyle, 2. fascia of the fore-arm, 3. back of the radius, and 4. of the ulna.

It is one of the muscles which belong to the common tendon arising from the external tubercle of the os humeri: it lies along the ulnar edge of the arm: it also arises from the intermuscular membrane, which separates this from the extensor digitorum and the extensor digiti minimi; and chiefly it is attached to the internal surface of the common sheath: it arises also from the face and edge of the ulna, the whole way down. Its tendon begins in the middle of its length, and is accompanied all down to the wrist with feather-like fleshy fibres.

In. head of the metacarpal bone of the little finger.

It is fixed into the outside of the head of the metacarpal bone of the little finger.

Its use is to extend the carpus. And it may be now observed, that when the two extensors of the wrist, the radialis and ulnaris, act, the hand is bent directly backwards; that when the flexor radialis and extensor radialis act together, they bend the thumb towards the radius; and that when the flexor ulnaris and extensor ulnaris act, they draw down the ulnar edge of the hand.

Extensor digitorum communis.

C. Extensor digitorum communis. — This muscle corresponds with the sublimis and profundus, and antagonises them, and resembles them in shape as in use. It covers the middle of the fore-arm at its back, and lies betwixt the extensor radialis brevior and the extensor minimi digiti.

Or. 1. outer condyle, 2. fascia, 3. interosseous lig. 4. back of the radius.

Its origin is chiefly from the outer condyle, by a tendon common to it, with the extensor carpi radialis brevior; it comes also from the intermuscular membrane, which separates it on one side from the extensor minimi digiti, and on the other from the extensor carpi radialis brevior; and lastly, from the back part of the common sheath. It grows very

fleshy and thick as it descends, and about the middle of the fore-arm it divides itself into three slips of very equal size. But though the tendons begin so high, they continue, like those of the flexors, to receive fleshy penniform fibres all down, almost to the annular ligament. These tendons are tied together by a loose web of fibres, and being gathered together they pass under the ligament in one common and appropriated channel. Having passed this ligament they diverge and grow flat and large. And they all have the appearance of being split by a perpendicular line. They are quite different from the flexor tendons in this, that they are all tied to each other by cross bands; for a little above the knuckles, or first joint of the fingers, all the tendons are joined on the back of the hand by slips from the little finger to the ring finger, from the ring finger to the mid finger, and from that to the fore finger. So that it seems to be one ligament running quite across the back of the hand. It would be foolish to describe them more minutely: for the cross bands change their places, and vary in every subject, and in some they are not found.

In fore, middle, and ring finger.

After this, the tendons pass over the heads of the metacarpal bones, along the first phalanx of the fingers, and being there joined by the tendons of the interossei and lumbricales, they altogether form a strong tendinous sheath, which surrounds the back of the fingers.

Now it is to be remembered, that this muscle serves only for the fore, middle, and ring fingers: that if it moves the little finger, it is only by a small slip of tendinous fibres, which it often gives off at the general divergence, but sometimes not: sometimes it gives one slip; sometimes two; often none at all. And so the little finger has its proper extensor quite distinct from this.

The use of the muscle is to extend all the fingers; and when they are fixed, it will assist the extensors of the wrist, as in striking backwards with the knuckles.

CI. The EXTENSOR MINIMI DIGITI, named also AURICULARIS, from its turning up the little finger, as

Extensor minimi digiti.

in picking the ear, should really be described with the last muscle; if we see the origin, course, and use of this muscle exactly the same with it, why should we not reckon it as a slip of the common extensor, appropriated to the little finger?

Or. 1. outer condyle, 2. fascia, 3. inteross. ligament, 4. back of the ulna.

Its origin is from the outer condyle, along with the other tendons. It also adheres so closely both to the tendinous partitions, and to the internal surface of the common fascia, that it is not easily separated in dissection. It begins small, with a conical kind of head; it gradually increases in size; it is pretty thick near the wrist; it adheres all along to the common extensor of the fingers; it begins to be tendinous about an inch above the head of the ulna: it continues to receive fleshy fibres down to the annular ligament, and it passes under the annular ligament, in a channel peculiar to itself, which is indeed the best reason for making this a distinct muscle.

In. last phalanx of the little finger.

This channel has a very oblique direction, and the tendon, like all the others, expands greatly in escaping from the ligament of the wrist. It is connected with the other tendons, in the manner I have described. Close to the wrist, it is connected with the tendon of the ring finger, by a slip which comes from it; and at the knuckle, and below it, it is again connected with the tendons both of the ring finger, and of all the others, by the cross bands or expansions.

Whatever has been said of the use of the last muscle, is to be understood of this; as its extending its proper finger, assisting the others by its communicating band, and in its extending the wrist, when the fist is clenched. Its insertion is into the back of the second joint of the little finger, along with the interossei and lumbricales. Its tendon has also a small slit; for the head of the proper extensor of the little finger, and the heads of the common extensors of the others, are inserted into the top of the second phalanx, just under the first joint. They send off at the sides tendinous slips, which, passing along the edges of the bones, do, in conjunction with the tendons of the interossei and lumbricales, form a split

tendon, which meets by two curves at the foot of the last bone of the fingers, to move the last joint.

CII. The EXTENSOR PRIMUS POLLICIS, or extensor primi internodii pollicis, is the shortest of the three. It is named by Albinus and others ABDUCTOR LONGUS; but since every muscle that extends the thumb must pull it away from the hand, every one of them might be, with equal propriety, named abductors. *Extensor primus pollicis.*

The extensor primus lies just on the fore edge of the radius, crossing it obliquely.

It arises about the middle of the fore-arm, from the edge of the ulna, which gives rise to the interosseous membrane itself, and also from the convex surface of the radius. *Or. 1. edge of the ulna, and 2. convex surface of the radius.*

The fleshy belly commonly divides itself into two or three, sometimes four fleshy slips, with distinct tendons, which, crossing the radius obliquely, slip under the external ligament of the carpus, and are implanted into the trapezium and the root of the first metacarpal bone, or rather of the first phalanx of the thumb, towards the radial edge, so that its chief use is to extend the thumb, and to incline it a little outwards towards the radius. It has also frequently a tendon inserted into the abductor pollicis. It must also, like the extensors of the fingers, be an extensor of the wrist: and it evidently must, from its oblique direction, assist in supination. *In. 1. trapezium, and 2. metacarpal bone of the thumb.*

CIII. The EXTENSOR SECUNDUS POLLICIS is longer than the first. It is named by Douglas the extensor secundi internodii pollicis; by Albinus, the extensor minor pollicis. *Extensor secundus pollicis.*

This muscle lies close by the former. It arises just below it, from the same edge of the radius, and from the same surface of the interosseous membrane, it runs along with it in the same bending course; and, in short, it resembles it so much, that Winslow has reckoned it as part of the same muscle. *Or. 1. edge of the ulna, 2. inteross. lig. and 3. the radius.*

Its origin is from the edge of the ulna, the interosseous ligament, and the radius. Its small round tendon passes sometimes in a peculiar channel, sometimes with the extensor primus. It goes over the

In. 1st and 2d phalanges of the thumb. metacarpal bone of the thumb; it expands upon the bone of the first phalanx; and it is inserted just under the second joint.

It extends the second bone of the thumb upon the first; it extends the first bone also; and it extends the wrist, and by its oblique direction, contributes to supination.

Extensor tertius pollicis. CIV. EXTENSOR TERTIUS POLLICIS. — This, which bends the third joint, is called in common the extensor longus pollicis, or extensor tertii internodii pollicis. And here is a third muscle, which, in form, and place, and function, corresponds with the two former ones.

Or. 1. ridge of the ulna, and 2. interosseous lig. Its origin is from the ridge of the ulna, and from the upper face of the interosseous membrane; and it is a longer muscle than the others, for it begins high, near the top of the ulna, and continues the whole way down that bone, and is very fleshy and thick. It is penniform all the way down to the ligament of the wrist; and its small tendon passes the ligament in a peculiar ring. This tendon appears split, like those of the fingers; it goes along the ulnar side of the first bone of the thumb, reaches the second, and is implanted there by a small slip of tendon; and being expanded, it still goes forward to be inserted once more into the third bone of the thumb at its root. *In.* last phalanx of the thumb.

Its use is evident, after describing the others: for we have only to add another joint for motion. It moves the last joint of the thumb, then the second, then its metacarpal bone upon the carpus; and if that be held firm, it will extend the carpus; and it will, in its turn, contribute to supination, though in a less degree than the others.

Indicator. CV. INDICATOR. — The EXTENSOR INDICIS PROPRIUS has very nearly the same origin, and exactly the same course with the last, and lies by the side of it.

Or. 1. ridge of the ulna, 2. inteross. lig. Its origin is from the ulna, by the side of the extensor longus pollicis. It has also some little attachments to the interosseous membrane. It, like the others, is feathered with fibres in an oblique direction down to the ligament of the wrist.

This muscle lies under the extensor communis digitorum: its tendon passes along with the common tendon, through the annular ligament; and near the top of the metacarpal bone, or about the place of the common junctions of all these tendons, this one joins with the indicator tendon of the common extensor.

Its use is in extending all the three joints of the fore finger; assisting the common extensor in pointing with that finger; in acting independently of the common extensor; and in helping to extend the wrist, when the fingers are closed.

To last phalanx of the fore finger.

MUSCLES SEATED ON THE HAND.

Besides these muscles which bend and extend the fingers, there are other smaller ones seated on the hand itself, which are chiefly for assisting the former, and for quicker motions, but most especially for the lateral motions of the fingers, and which are named ADDUCTORS, ABDUCTORS, and FLEXORS, when they belong to the thumb and to the little finger.

That they are chiefly useful in assisting and strengthening the larger muscles, is evident from this, that much power being required for flexion, we find many of these smaller muscles added in the palm of the hand; but as there is little power of extension needed, no more almost than to balance the power of the flexors, there are no small muscles on the back of the hand, the interossei externi excepted, which are chiefly useful in spreading the fingers.

The short muscles in the palm of the hand are for bending the thumb, the fore finger and the little finger; and the little finger and the thumb have each of them three distinct muscles; one to pull the thumb away from the hand, one to bend it, and one to pull it towards the hand, opposing it to the rest of the fingers, and so of the little finger, which has also three muscles.

All the muscles of the thumb are seated on the inside, to form the great ball of the thumb; and it is not easy at first to conceive how muscles having so much the same place should perform such opposite motions; yet it is easily explained, by the slight variation of their places; for the ABDUCTOR arises from the annular ligament near the radius, and goes towards the back of the thumb.

The flexors arise deeper, from bones of the carpus, and from the inside of the ligament, and go to the inside of the thumb. The ADDUCTOR arises from the metacarpal of the mid finger, and goes to the inner edge of the thumb.

Abductor pollicis. | *Or.* 1. annular lig. 2. trapezium. | *In.* back part of second bone of the thumb.

CVI. The ABDUCTOR POLLICIS is only covered by the common integuments. It begins a little tendinous from the outside of the annular ligament, just under the thumb, and by some little fibres from the trapezium; and, from the tendon of the long abductor or extensor primus, it bends gradually round the thumb, and is at last inserted in the back of the first joint, just above the head of the metacarpal bone. But it does not stop here; for this flat tendon is now expanded into the form of a fascia, which, surrounding the first bone of the thumb, goes forward upon its back part, quite to the end, along with the common tendon of the extensor. This muscle, like the others, is covered by a thin expansion from the tendon of the palmaris, as well as by the common integuments.

Its only use is to pull the thumb from the fingers, and to extend the second bone upon the first.

Albinus describes a second muscle of the same name, having the same course, origin, insertion, and use: it also arises from the outer side of the ligament of the wrist, and is fixed into the side of the thumb, and lies upon the inside of the former muscle.

These two are inserted into the first bone of the thumb; but the next is inserted into the metacarpal bone.

Opponens pollicis.

CVII. The OPPONENS POLLICIS is often called the flexor of the metacarpal bone of the thumb. It is

placed on the inside, and implanted into the side of the thumb: its office is to draw the thumb across the other fingers, as in clenching the fist; and from its thus opposing the fingers it has its name of opponens.

It lies immediately under the last described muscle, and is like it in all but its insertion.

It arises from the trapezium, and from the ligament of the wrist. It is inserted into the edge and fore part of the metacarpal bone of the thumb; and its use is to turn the metacarpal bone upon its axis, and to oppose the fingers; or, in other words, to bend the thumb; for I can make no distinction. Therefore, this muscle and the next, which lies close upon it, may be fairly considered as but two different heads of one thick short muscle.

Or. 1. annular lig. and 2. trapezium.

In. metacarpal bone of the thumb.

CVIII. The FLEXOR BREVIS POLLICIS is a two-headed muscle, placed quite on the inside of the thumb, betwixt the fore finger and the thumb, and extends obliquely across the two first metacarpal bones. It is divided into two heads by the long flexor of the thumb.

Flexor brevis pollicis.

The edge of this muscle lies in close contact with the edge of the last, or opponens; and indeed they may fairly be considered as one large muscle surrounding the basis of the thumb.

One head arises from the os trapezium, or base of the thumb, and from the ligament of the wrist. The other head comes from the os magnum and unciforme, and from the ligaments which unite the bones of the carpus.

Or. 1. trapezium, 2. magnum, and 3. unciforme.

The first head is the smaller one: it terminates by a pretty considerable tendon in the first sesamoid bone. The second head runs the same course: it is implanted chiefly in the second sesamoid bone, and also into the edge of the first bone of the thumb close by it. The second head is exceedingly muscular and strong. The heads are completely separated from each other by the tendon of the flexor longus passing betwixt them.

In. ossa sesamoidea.

The office of this muscle is to bend the first joint upon the second, and the metacarpal bone upon the carpus: and indeed the office of this, and of the opponens, is the same. It is in the tendons of this double-headed muscle that the sesamoid bones are found.

Adductor pollicis.
Or. Metacarpal bone of the middle finger.
In. root of the second bone of the thumb.

CIX. The ADDUCTOR POLLICIS arises from the metacarpal bone of the middle finger, where it has a flat extended base. It goes from this directly across the metacarpal bone of the fore finger, to meet the thumb. It is of a triangular shape, and flat: its base is at the metacarpal bone; its apex is at the thumb: it is inserted into the lower part or root of the first phalanx: its edge ranges with the edge of the flexor brevis: it concurs with it in office; and its more peculiar use is to draw the thumb towards the fore finger, as in pinching.

Thus do these muscles, covering the root of the thumb, form that large ball of flesh which acts so strongly in almost every thing we do with the hand.

The ball of the thumb is fairly surrounded; it is almost one mass, having one office; but as the deltoides will, in some circumstances, pull the arm downwards, some portions of this fleshy mass pull the thumb outwards obliquely; some directly inwards: but the great mass of muscle bends the thumb, and opposes it to the hand: and as this one muscle is to oppose the whole hand, the ball of flesh is very powerful and thick.

The short muscles of the little finger surround its root, just as those of the thumb surround its ball.

Abductor minimi digiti.
Or. 1. os pisiforme. 2. metacarpal bone, and 3. annular lig.
In. root and outside of the third phalanx.

CX. The ABDUCTOR MINIMI DIGITI is a thin fleshy muscle, which forms the cushion on the lower edge of the hand, just under the little finger. It is an external muscle: it arises from the os pisiforme, and metacarpal bone of the little finger, and from the outer end of the annular ligament. It is inserted laterally into the first bone of the little finger; but a production of it still goes forward to the second bone of the little finger.

Its use is to spread the little finger sideways, and perhaps to assist the flexors.

CXI. The FLEXOR PARVUS MINIMI DIGITI is a small thin muscle which rises by the side of the last, and runs the same course, with nearly the same insertion.

Flexor parvus minimi digiti.

Or. 1. annular lig. and 2. os unciforme.

Its origin is from the ligament of the wrist, and in part from the crooked process of the unciform bone. Its use is to bend the little finger. And indeed the office and place of both is so much the same, that I have marked the last as a flexor; the little difference there is, is only that this performs a more direct flexion.

In. root and side of the first phalanx.

CXII. The ADDUCTOR MINIMI DIGITI is sometimes called the metacarpal of the little finger. It lies immediately under the former muscle. Its origin is from the hook of the unciform bone, and the adjoining part of the carpal ligament.

Adductor minimi digiti.

Or. 1. annular lig. and 2. os unciforme.

It is inserted into the outside of the metacarpal bone, which it reaches by turning round it. Its use is to put the little finger antagonist to the others: it is to this finger what the opponens is to the thumb. It also, by thus bending one bone of the metacarpus, affects the whole, increases the hollow and external convexity of the carpus, and forms what is called Diogenes's cup.

In. outside of the metacarpal bone.

CXIII. The ABDUCTOR INDICIS is a flat muscle of considerable breadth, lying behind the adductor pollicis, and exactly resembling it, being like the second layer. It arises from the os trapezium, and from the first bone of the thumb; and it is inserted into the back part of the first bone of the fore finger, and pulls it towards the thumb.

Abductor indicis.

Or. 1. trapezium, and 2. metacarpal bone of the thumb.

In. back of the first bone.

The INTEROSSEI are situated betwixt the metacarpal bones. They are small, round, and neat, something like the lumbricales in shape and size, and in office resemble the adductors and abductors. Four are found in the palm which bend the fingers, and draw their edges a little towards the thumb; three are found on the back of the hand, for extending the

fingers; they at the same time perform the lateral motions of the fingers.

Interossei interni. *Or.* sides of the metacarpal bones. *In.* with the lumbricales.

CXIV. The INTEROSSEI INTERNI arise from betwixt the metacarpal bones. They are also attached to the sides of these bones. They send their tendons twisting round the sides to the backs of these bones. And they are inserted along with the tendons of the lumbricales and extensors, into the back of the finger. They are thus flexors of the first joint, and extensors of the second joint, as the lumbricales are.

Interossei externi. *Or.* roots of the metacarpal bones, having two heads. *In.* tendinous expansion of the extensor communis.

CXV. The INTEROSSEI EXTERNI are three in number. They arise, like the interni, from the metacarpal bones and their interstices, and from the ligaments of the carpal bones. They are peculiar in having each two heads, therefore named interossei bicipites. They join their tendons to those of the extensor and lumbricales; they have therefore one common office with them, that is, extending all the joints of the fingers. Many have chosen to describe the origin and insertion with most particular care, marking the degree of obliquity, and ascertaining precisely their office, and giving particular names to each, as prior indicis for the first external; all which I forbear mentioning, because they must be more liable to perplex than assist: if we but remember their common place and office, it is enough. The tendons of the flexor muscles bend round the finger, along with the interossei and lumbricales, for a surer hold; consequently the tendons of the lumbricales, of the interossei interni, of the extensors, and of the interossei externi, meet upon the backs of the fingers, which are by them covered with a very strong web of tendinous fibres.

MUSCLES OF RESPIRATION, OR, OF THE RIBS.

The whole back is clothed with strong muscles, and all its holes, irregularities and spines, are crossed with many smaller ones. These muscles are related either to the arm, to the ribs, or to the spine, *i. e.* the vertebræ, whose motions they perform; and from this we obtain an arrangement not inconsistent with the regular order of their office, and yet corresponding with the best order of dissection.

The first, or uppermost layer of muscles, viz. the trapezius, the levator scapulæ, the rhomboidei, the latissimus dorsi, belong principally to the arm. The serrated muscles which lie next under these are muscles of respiration, and belong to the ribs; while the splenius and complexus, the muscles of the neck, the longissimus dorsi, sacro-lumbalis, and the quadratus lumborum, which are muscles of the back, and the innumerable smaller muscles which lie betwixt the vertebræ, belong entirely to the spine.

The muscles of respiration properly which are appropriated to the ribs, performing no other motion, are,

1. The SERRATUS POSTICUS SUPERIOR,	which comes from the neck, and lies fleshy over the ribs, to pull them upwards.
2. The SERRATUS INFERIOR POSTICUS,	which comes from the lumbar vertebræ, and lies flat on the lower part of the back, to pull the ribs downwards.
3. The LEVATORES COSTARUM,	which are twelve flat muscles arising from the transverse process of each vertebra, and going down to the rib below: they raise the ribs.

4. The INTERCOSTAL MUSCLES, { which lie betwixt the ribs, and fill up all the space betwixt rib and rib; they also raise the ribs.

And there may be added to these, that muscle, which, lying under the sternum, and within the thorax, is called triangularis sterni, and pulls the ribs downwards.

Serratus sup. post. *Or. 3 inf. spines of the neck. 2 of the sup. of the back.*

CXVI. The SERRATUS SUPERIOR POSTICUS lies flat upon the side of the neck, under the trapezius and rhomboideus, and over the splenius, and complexus muscles. It arises by a flat and shining tendon from the spines of the three lower vertebræ of the neck, and the two uppermost of the back. It goes obliquely downwards under the upper corner of the scapula, and is inserted into the second, third, fourth, and fifth ribs, by three or four neat fleshy tongues.

In. 2d, 3d, 4th, 5th, ribs.

The ligamentum nuchæ is chiefly formed by the meeting of the trapezii muscles; but the flat tendons of these upper serrated muscles help to form it. They are purely levators of the ribs; their effect upon the vertebræ, if they have any, must be very slight.

Serrat. inf. post.

CXVII. The SERRATUS INFERIOR POSTICUS is a very broad thin muscle, situated at the lower part of the back, under the latissimus dorsi, or over the longissimus dorsi muscle.

Or. 2 lower vert. of the back, 3 sup. of the loins.

It arises, in common with the latissimus dorsi, from the spines of the two lower vertebræ of the back, and the three uppermost vertebræ of the loins. Their origin, like that of the latissimus, is by a thin tendinous expansion; it soon becomes fleshy, and, dividing into three, sometimes four, fleshy strips or tongues, each of them is inserted separately into the ninth, tenth, eleventh, twelfth, lower ribs, near their cartilages. So that this muscle, spreading so wide out from the centre of motion, has vast power; for it has the whole length of the rib as a lever.

In. 4 inferior ribs.

The office of it is to pull the ribs downwards and backwards, the effect of which must be to compress the chest, and in certain circumstances to turn the spine.

CXVIII. The LEVATORES COSTARUM are twelve muscles on each side, for the direct purpose of raising the ribs; they lie above or upon the ribs, at their angles, and are thence named, by some, SUPRA COSTALES.

Levatores costarum.

They are almost a portion of the external intercostal muscles. The first of the levators arises from the transverse process of the last vertebra of the neck, and goes down to be inserted into the first rib, near its tuberosity; and so all that follow arise from a transverse process, and go to the rib below, being very small and tendinous at each end; but the three last levators arise from the second process, above the rib to which they belong: they pass one rib to go into the one below it; they are consequently twice as long as the nine first are, and are therefore named LEVATORES COSTARUM LONGIORES, from the ninth downwards.

Or. transverse process of the vertebræ.
In. sup. margin of the rib.
Longiores.

Thus, the levatores costarum are a succession of small muscles, arising from the transverse processes of the vertebræ, and going to the angles of the ribs, beginning from the last vertebra of the neck, and ending with the last but one of the back. They lie under the longissimus dorsi, and sacro-lumbalis; and often they have connections with these muscles, sometimes very close.

CXIX. CXX. The INTERCOSTALES EXTERNI run obliquely from the lower edge of one rib, downward and forward, or in a direction from behind forward, beginning from the spine, to be inserted into the upper edge of the rib below; the muscle is not continued into the space betwixt the cartilages of the ribs. The internal, again, are perfect betwixt the cartilages of the ribs, but they proceed no further back than the angles of the ribs. They are further different from the internal muscles, inasmuch as they pass obliquely backward and downward from the margin of the one rib to the other.

Intercostales externi.
Or. lower edge of the rib.
In. sup. edge of next rib.
Intercost. interni.
Or. sup margin the rib.
In. Inf. margin of next rib.

These two rows were thought to antagonize each other; the one to pull the ribs downwards, the other to raise them; but I shall not stop to explain this, nor to refute it; it is sufficient to declare their true

although in the common exercise of the arms they are voluntary muscles, in the excited condition of the respiratory organs they become powerful agents of inspiration.

MUSCLES OF THE HEAD, NECK, AND TRUNK.

THE serratus superior posticus being raised, the splenii come into view, and the splenii being also lifted, the complexus is fully exposed.

Splenius.

CXXII. SPLENIUS. — The two splenii are so named from their lying like surgical splints, along the side of the neck; both together they have the appearance of the letter Y; the complexus being seen betwixt them in the upper part of the angle. They lie immediately under the trapezii, and above the complexus.

Or. 4 sup. spines of the back, and 5 inf. of the neck.

In. 3 sup. transv. processes of the vert. of the neck, the mastoid process, the os occipitis.

Each splenius is a flat and broad muscle, which arises from the spinous processes of the neck and back, and is implanted into the back part of the head. It arises from the four upper spines of the back, and the five lower of the neck; it parts from its fellow at the fifth vertebra of the neck, so as to show in the interstice two or three of the uppermost spines of the neck, with the upper part of the complexus muscle; each splenius goes obliquely outwards to be inserted into the occipital ridge, and all along to the root of the mastoid process. At the third vertebra of the neck, where the two splenii muscles part from each other, the tendons of the opposite splenii are closely connected both with each other and with the common tendon, which is called ligamentum nuchæ.

This is the SPLENIUS CAPITIS; but there is a portion of this same muscle which lies under this, and which has the same common origin, but which terminates

by four or five distinct tendons in the transverse processes of the upper vertebræ of the neck. This portion may be dissected apart, and has been considered by many as a muscle, the SPLENIUS COLLI of Albinus; who has distinguished as splenius capitis all that part arising from the spines of the neck, and implanted into the head; and as the splenius colli, all that part which arises from the vertebræ of the back, and is implanted into the transverse processes of the neck.

These splenii are the right antagonists of the mastoid muscles; both the splenii acting, pull the head directly backwards; one acting turns the head and neck obliquely to one side; one acting along with the corresponding mastoid muscle, lays the ear down upon the shoulder.

CXXIII. The COMPLEXUS is named from the intricacy of its muscular and tendinous parts, which are mixed; from the irregularity of its origins, which are very wide, it has the names of COMPLEXUS IMPLICATUS TRIGEMINUS, by which the student is warned of the difficulty of understanding this muscle. Complexus.

It lies immediately under the splenius; arises by distinct tendons, with ten or more tendinous feet, from the four lower transverse processes of the vertebræ of the neck, and from the seven uppermost of the back; having also some less regular origins, as from two spines of the back and from four oblique processes in the neck. It grows into a large muscle, which is not like the splenius, flat and regular, but thick, fleshy, composed of tendon and flesh mixed, filling up the hollow, by the sides of the spines of the neck, and terminating in a broad fleshy head, which is fixed under the ridge of the occipital bone; and this is the part which is seen in the angle or forking of the splenii.

Or. 7 sup. transv. processes of dorsal vert. 4 inf. of the neck; spinous process of the 1st of the back.

Is. the occipital bone in the line from the tuber to the mastoid process.

This may stand as the general description of the muscle considered as one. But Albinus has chosen to describe it as two muscles, under two different names, with a minuteness which, far from clearing the demonstration of any difficulties, makes it less distinct; and if any thing could complete the con-

fusion, it was his humour of calling that BIVENTER, which had been hitherto named COMPLEXUS, and naming the lower part of the muscle COMPLEXUS, though it had never been distinguished from the rest.

The BIVENTER of ALBINUS is the upper layer of the muscle, that part which appears in the fork of the splenii: and if we have hitherto named it complexus, from its mixture of tendons and flesh, it was particularly improper to transfer that name to another part of the muscle which is less complicated. This upper layer, the BIVENTER CERVICIS, is attached by a large broad head to the occipital bone; in the centre of this belly there is a confusion of tendon; then there is a middle tendon about the middle of the arch of the neck, and the lower part of the biventer arises from two parts; first, by one slip of flesh from the two uppermost spines of the back; and, secondly, by a larger fleshy portion which comes from the fourth, fifth, sixth, and seventh transverse processes of the back. And it is from the upper and lower fleshy heads and the confused middle tendon that it is called biventer.

The COMPLEXUS of ALBINUS lies below this one. It arises, by three tendinous and fleshy slips, from the three upper transverse processes of the back. Then it has four other slips from four oblique or articulating processes of the neck; which various origins are gathered into one thick irregular fleshy belly, which is implanted into the occiput under the great head of the biventer, and mixed with it. This I have chosen to explain, lest the student should be embarrassed by false names; referring him to the first paragraph for the true and simple description of this muscle.

Trachelo-mastoideus. CXXIV. TRACHELO-MASTOIDEUS.* — The last muscle is often named COMPLEXUS MAJOR, and this COMPLEXUS MINOR; but a fitter name is the TRACHELO-

* It is the TRACHELO-MASTOIDEUS, the MASTOIDEUS LATERALIS, the CAPITIS PAR-TERTIUS, the COMPLEXUS MINOR; by some it is considered as a part of the COMPLEXUS.

MASTOIDEUS, from its origin in the neck, and its insertion in the mastoid process.

Its origin is from the three first vertebræ of the back, and from the five lowest of the neck at their transverse processes. Its origins are by distinct tendons, and its belly is in some degree mixed of tendon and flesh, whence its name of complexus minor. It is inserted into the mastoid process, just under the insertion of the occipital part of the splenius; and indeed its long and flat belly lies all along under that muscle, so that the order of dissection is this: 1. The TRAPEZIUS. 2. The SPLENIUS CAPITIS. 3. The SPLENIUS COLLI. 4. The TRACHELO-MASTOIDEUS.

Or. the 3 uppermost transverse processes of the vertebr. of the back, and the 5 lowest of the neck. *In.* back of the mastoid process.

It is needless to speak of its use, since the use of all these muscles is to draw the head backwards directly, when both act; obliquely, when one acts alone.

The RECTI MUSCLES are two deep-seated muscles, which go immediately from the vertebræ to the occiput, to be inserted into its lower ridge. They are called major and minor.

CXXV. The RECTUS MINOR is the shorter of the two, arising from the first vertebra of the neck. Its place of origin is a small tuber which stands in the place of the spinous process of the first vertebra; and from that point, where it is tendinous, it goes up to the occipital ridge, and is inserted fleshy.

Rectus minor. *Or.* tuber of the atlas. *In.* edge of os occipitis.

CXXVI. The RECTUS MAJOR is larger. It arises, in like manner, tendinous, from the second vertebra of the neck at its spinous process, and mounting from that, is inserted fleshy into the lower ridge of the occiput without the former. These are so placed that the recti minores appear in the interstice of the recti majores. And though we call them both recti, yet they cannot truly be so; for the recti minores must be, in some degree, oblique, and the recti majores still more so; and, consequently, although their chief use be conjointly to draw the head directly backwards, yet one acting must turn the head to its

Rectus major. *Or.* spinous pro. of the dentatus. *In.* os occipitis.

side. And indeed the same may be said of all the muscles of the neck.

The OBLIQUUS SUPERIOR and OBLIQUUS INFERIOR correspond very closely in all things with the recti, but in their oblique direction; the uppermost, as being much shorter, has been named obliquus minor, the lower one obliquus major.

Obliquus superior. *Or.* trans. pro. of the atlas.

CXXVII. The OBLIQUUS SUPERIOR arises from the transverse process of the atlas, and is inserted into the end of the lower occipital ridge. Its use, notwithstanding its oblique position, is not to turn, but to bend, the head backwards, for the occipital condyles, standing obliquely, do not permit the rotatory motion of the head on the first vertebra. Its insertion into the occiput is under the splenius and complexus; but one edge of it is above the insertion of the rectus major.

In. end of the lower occip. ridge.

Obliquus inferior. *Or.* spinous pro. of the dentatus. *In.* trans. pro. of the atlas.

CXXVIII. The OBLIQUUS INFERIOR arises from one vertebra and goes to another. It arises from the spine of the second vertebra: it goes to the transverse process of the first, and it meets the superior oblique muscle; and this one obtains great power, by the lateral projection of the atlas giving it a lever power. The first vertebra or atlas rolls on the tooth-like process of the dentatus; and while the great and slow motions of the neck in general are performed by other muscles, there is a presumption, that the short and quick turnings of the head are performed by these oblique muscles.

MUSCLES OF THE TRUNK.

The great muscles which move the back and loins are the QUADRATUS LUMBORUM, SACRO-LUMBALIS, and LONGISSIMUS DORSI.

The sacro-lumbalis and longissimus dorsi run by the side of the spine, and lie immediately under the latissimus dorsi, which is the outer layer; the quadratus lumborum lies again under these, and next to the abdominal cavity. Although the quadratus lum-

borum lies deep under the longissimus dorsi muscle, I shall describe it first, for the sake of a connection which will be presently understood.

CXXIX. The QUADRATUS LUMBORUM is a flat squared muscle, named quadratus from its square, or rather oblong form. It arises fleshy from two or three inches of the back part of the os ilium, and from the ligaments of the pelvis which tie the back part of the ilium to the side of the sacrum, and to the transverse processes of the loins. As it goes upwards along the side of the lumbar vertebræ, it takes hold of the points of the transverse processes of each, by small tendinous slips; so that we are almost at a loss whether to consider these as new origins or as insertions: but its chief insertion is into the lower edge of the last rib; and a small production of it slips under the arch of the diaphragm, to be implanted into the body or fore part of the last vertebra of the back.

Quadratus lumborum.

Or. 1. spine of ilium. 2. trans. pro. of lumbar vert.

In. last rib, and last dorsal vert.

The LONGISSIMUS DORSI and SACRO-LUMBALIS have their origin in one common and broad tendon coming from the sacrum, ilium, and loins: the two muscles lie alongside of each other: the longissimus dorsi is nearer the spine, and keeps its tendons closer by the spine. The sacro-lumbalis is farther from the spine, and spreads its tendinous feet broader upon the sides of the thorax; and if one be a little under the other, it is the outer edge of the longissimus dorsi, which is a little under the edge of the lumbar muscle.

The common tendon and muscle (for there is for some way but one muscle) begins thus; it may be said to have two kinds of adhesion: for, first, externally it appears a broad, flat, and shining tendon, which arises tendinous from all the spines of the lumbar vertebræ; from the spines of the sacrum, and from the back part of the os ilium: but the inner surface of this broad tendon is strongly fleshy; for it arises fleshy from the back part of the ilium; from the deep hollow betwixt the ilium and sacrum; from the sides of the long spines of the lumbar vertebræ; and from their articulating processes, and the roots

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of their transverse processes. In short, its origin is all tendinous without, and all fleshy within; and its flesh arises from all that irregular surface which is on either side of the spine betwixt the os ilium and the vertebra of the loins; and thus it continues one strong tendinous and fleshy muscle, filling up all the hollow of the loins. There is an appearance of separation, something like a split in the tendon, which shows in the loins what part of the tendon belongs to each muscle; but it is only in the back that they are fairly divided.

Just opposite to the lowest rib, the longissimus dorsi and sacro-lumbalis break off from the common tendon; and the longissimus keeps close by the vertebræ, while the sacro-lumbalis is implanted into the ribs.

Longiss. dorsi. *Or.* 1. the os sacrum, 2. spine of the os ilii, 3. spinous and transverse processes of the loins. *In.* 1. the transverse processes of the vert. of the back, 2. the lower edge of all the ribs except the two lowest.

CXXX. The LONGISSIMUS DORSI is a muscle of the spine. It is not a flat muscle, but round, thick, and firm, filling up all the hollow betwixt the spine and the angle of the ribs. It is of a long form, as its name implies, terminating towards its top almost in a point. It has two distinct sets of feet by which it is inserted; one set of feet more fleshy, but small and neat, go outwards from the side, as it were, of the muscle, to be implanted near the heads of the ribs; the lower ones farther out than the heads of the ribs; the upper ones close to the head, and consequently closer to the spine. These heads are nine or ten in number, corresponding with the nine or ten uppermost ribs. Another set of heads, which are not so well seen as this set, because they lie more under the muscle, are small, neat, and tendinous; they go in an opposite direction, viz. inwards and upwards; keep closer by the spine, and are inserted into the transverse processes of the vertebræ of the back. This set of heads is thirteen in number, implanted into the transverse processes of all the back, and of one vertebra of the neck.

Sacro-lumbalis.

CXXXI. The SACRO-LUMBALIS separates from the longissimus dorsi at the last rib, and is a flatter and less fleshy muscle: its twelve tendons are flatter than

those of the longissimus dorsi, and go out wider from the spine. The tendons next to the longissimus dorsi run highest up, and are the longest; those farthest from the spine, *i. e.* farthest out upon the chest, are the shortest. It has a flat tendon for each rib, which takes hold upon the lower edge of the rib. But it has another order of small muscles which mix with it; for as the longissimus dorsi has a double row of insertions, this has another set of attachments, for there arises from the surface of each rib, at least of the six or seven lowest ribs, a small slip of flesh, which runs into the substance of the sacro-lumbalis, and mixes with it; and these fleshy slips go by the name of the ADDITAMENTUM AD SACRO-LUMBALEM, or MUSCULI ACCESSORII.

Or. in common with the last.

In. all the ribs at their curvatures.

N. B. The accessorii arise from the six or eight lower ribs, and run into its substance.

Both these muscles, viz. the longissimus and sacro-lumbalis, terminate in points which reach towards the neck, and under the point of each there lie the roots of two small muscles, which go up to move the neck. Many have referred these slips going up into the neck entirely to the muscles I am now describing, calling one an ascending slip of the longissimus dorsi, and the other a slip of the sacro-lumbalis, while others have described them as distinct muscles, having but slight connections with the longissimus and sacro-lumbalis. Their proper names are CERVICALIS DESCENDENS, and TRANSVERSALIS COLLI.

Cervicalis descendens.

Or. 5 lowest transv. processes of the neck.

In. six uppermost ribs.

CXXXII. The CERVICALIS DESCENDENS is connected with the sacro-lumbalis muscle; it cannot be entirely referred to it, for the cervicalis descendens arises as a distinct muscle from the five lower vertebræ of the neck, at their transverse processes, goes downwards very small and slender to be inserted into the six uppermost ribs, to get at which it slips under the longest tendons of the sacro-lumbalis; but that the cervicalis descendens does not belong to the sacro-lumbalis may be inferred from its having distinct tendons from six ribs, and from five transverse processes of the neck, and from these tendons being in a direction which does not at all correspond with the heads of the sacro-lumbalis. Indeed the longissi-

mus dorsi has a better claim to this muscle; for a long slip, partly tendinous and partly fleshy, runs upwards from the longest tendon of the longissimus dorsi, to join itself to the cervicalis descendens. Perhaps it would be better to consider it a continuation of the accessorii ad sacro-lumbalem.*

Transversalis colli.

Or. transverse processes of 5 upper dorsal vert.

In. trans. processes of all the cervic vert.

CXXXIII. The TRANSVERSALIS COLLI is that which Sabatier refers to the longissimus dorsi; but it is a distinct muscle arising, partly tendinous and partly fleshy, from the five upper transverse processes of the back; lies betwixt the trachelo-mastoideus and the cervicalis descendens; goes from the transverse processes of the back to the transverse processes of the neck, and has no more than a confused and irregular connection with any other muscle.

The QUADRATUS LUMBORUM keeps the trunk erect, by the action of both muscles at once; inclines it to one side, or turns it upon its axis, when one only acts; and by its insertion into the ribs, must assist in high breathing, by pulling down the ribs. The LONGISSIMUS DORSI has no power but over the spine, which it bends backwards, acting continually in keeping the trunk erect. This is also the chief use of the sacro-lumbalis; but the SACRO-LUMBALIS, going out further upon the ribs, takes such hold upon them, that besides its common action of raising the trunk, it may on occasions pull them down, assisting the quadratus and the lower serrated muscle. And it will have greater power in turning the trunk of the body upon its axis than the longissimus dorsi, which pulls almost directly backwards. The CERVICALIS DESCENDENS co-operates with the trachelo-mastoideus, and others,

* Hence it is plain that the sacro-lumbalis and longissimus dorsi have nearly an equal claim to this cervicalis descendens. For, first, the longissimus dorsi sends its longest tendons fairly up into the cervicalis descendens so far, that the slip is implanted into the transverse processes of the neck. And, secondly, the feet of the cervicalis descendens begin under the last tendons of the sacro-lumbalis, so as to have the appearance of arising from its supplementary muscle, the additamentum, and being a part of it; and indeed Sabatier has described it according to this view.

which turn the head to one side; and the cervicalis descendens bends the neck to one side, both the one and the other being independent muscles.

These two muscles bring us to mention that intricate set of muscles which fills up all the hollows and interstices among the spines and irregular processes of the vertebræ, which might be fairly reckoned as one muscle, since they are one in place and in office, but which the anatomist may separate into an infinite number, with various and perplexing names; an opportunity which anatomists have been careful not to lose.

The surface of the back, from the bulge of the ribs on one side, to the bulge of the ribs on the opposite side of the thorax, is one confused surface, consisting of innumerable hollows, processes, and points of bone; and it is tied, from point to point, with innumerable small muscles, or unequal bundles of mixed tendon and flesh. There are many points, as the spinous, transverse, and oblique processes of the vertebræ, and the bulging heads and angles of the ribs: and each process, or at least each set of processes, has its distinct sets of muscles and tendons.

1. There is one long continuity of muscular and tendinous fibres going from spine to spine, and lying on the side of the spinous processes along the whole length of the back and neck. This is divided into the SPINALIS CERVICIS and the SPINALIS DORSI.

2. There is a similar continuation of fibres, with less tendon and more flesh, belonging one half to the spinous and the other half to the transverse processes, whence it is named SEMI-SPINALIS DORSI.

3. There is a great mass lying all along the hollow of the back, on each side of the spinous processes, which, passing alternately from the transverse process of one vertebra to the spinous process of the next above, is of course split into many heads, but yet having such connection as to give it the form and name of a single muscle, the MULTIFIDUS SPINÆ.

4. and 5. There are yet smaller muscular fasciculi which stand perpendicularly betwixt every two trans-

verse and every two spinous processes; thence they are named INTER-TRANSVERSARII and INTER-SPINALES.

Semi-spinalis cervicis.

CXXXIV. The SPINALIS CERVICIS is that which is implanted into the spines of the cervical vertebræ; but because it does not go from spine to spine, like the spinalis dorsi, but from transverse processes to spines, it has been named by Winslow SEMI-SPINALIS, OR TRANSVERSO-SPINALIS COLLI. It arises from the transverse processes of the six upper vertebræ of the back, and is inserted into all the spinous processes of the vertebræ of the neck, except the first and last; and it extends the neck, or by its obliquity may contribute to the turnings of the neck, or to bending it to one side.*

Or. trans. process of the 6 upper dorsal vert. *In.* all the spinous processes of neck except the 1st and 7th.

Spinalis dorsi.

CXXXV. The SPINALIS DORSI arises from two spinous processes of the loins, and from the three lower spines of the back, and passing two spines untouched, it is implanted into all the spines of the back, except the uppermost. This muscle is very slender and long, and consists fully more of tendon than of flesh: it has five feet below, rising from the lower spines of the back and loins; and nine feet above, implanted into the upper spines of the back. Its action must raise the spine, but perhaps it may be equally useful, as a muscular and tendinous ligament.

Or. 2 upper lumb. vert. 3 lower dorsal vert. *In.* 8 or 9 sup. dorsal vert. except the 1st.

Semi-spinalis dorsi.

CXXXVI. The SEMI-SPINALIS DORSI arises from the transverse processes of the seventh, eighth, ninth, and tenth vertebræ of the back, and is implanted into the six or seven upper dorsal spinous processes and into the two last of the neck.†

Or. trans. process of the 7th, 8th, 9th vert. of the back. *In.* spines of 6 or 7 upper dorsal, and two lowest cervical.

CXXXVII. The MULTIFIDUS SPINÆ runs from the sacrum along all the spine to the vertebræ of the neck; and is a comprehensive and true way of describing many irregular portions of flesh, which

* The TRANSVERSALIS COLLI (*vide* p. 351.) is that which goes from the transverse processes of the back to the transverse processes of the neck; while this, the SPINALIS CERVICIS, goes from the transverse processes of the back to the spines of the neck.

† This is of course the TRANSVERSO-SPINALIS DORSI of Winslow.

authors have divided into distinct muscles.* It is a continued fleshy indentation, from transverse process to spine, through all the vertebræ of the back, neck, and loins.

It begins both tendinous and fleshy, from the upper convex surface of the os sacrum, which is rough with spines, from the adjoining part of the ilium; and in the loins, it arises from oblique processes: in the back, from transverse processes; and again from oblique processes, among the cervical vertebræ.

Its origin in the loins is close to the spine, being from the oblique processes, and from the root of the transverse processes. In the back it arises from the transverse processes, and therefore arises there by more distinct heads. In the neck again, it arises from the lower oblique processes, more confusedly.

Its bundles or fasciculi are inserted into the spinous processes, sometimes into the second, or even into the third or fourth spine, above that from which the bundle arises: for the tendons do not stop at that spinous process which they first touch, but go upwards, taking attachments to other two or three, and mixing their tendons with those of the fasciculi, above and below; and these tendons reach from the first of the loins to all the vertebræ up to the atlas, which is the only one not included.

The use of the multifidus spinæ is to retain the spine from being too much bent forward; for these muscles serve (as I have observed) the purpose of a ligament, and the best of all ligaments; having a degree of strength exactly proportioned to the necessity for strength. It also moves the spine backwards, though perhaps it is less useful in this than as a ligament; for we find it as strong in the vertebræ of the back, which have little motion betwixt the

* TRANSVERSO-SPINALIS LUMBORUM, SACER, SEMI-SPINALIS INTERNUS, sive TRANVERSO-SPINALIS DORSI, SEMI-SPINALIS, sive TRANSVERSO-SPINALIS COLLI, pars interna. — Winslow. TRANSVERSALIS LUMBORUM, vulgo SACER, TRANSVERSALIS DORSI, TRANSVERSALIS COLLI.

individual bones, and what little there is, must consequently be general. It seems rather intended to moderate the lateral motions of the vertebræ than to produce them: when it acts, its chief use is either to resist the spine being bent forward by a weight, or to erect the spine.

Inter-spinales. CXXXVIII. The INTER-SPINALIS COLLI, DORSI, and LUMBORUM, have varieties so little interesting that they need hardly be described. The INTER-SPINALES COLLI are stronger, because the neck has many and quick motions, and the bifurcated spines of the neck give broader surfaces for these muscles. The INTER-SPINALES DORSI are almost entirely wanting, because the spines of the back are close upon each other, and the vertebræ are almost fixed. The INTER-SPINALES in the LOINS are rather tendons or ligaments than proper muscles.

Inter-transversales. CXXXIX. The INTER-TRANSVERSALES are again stronger and fuller in the neck, because of the lateral motions of the neck being free, and its transverse processes forked. They are in more numerous bundles, where the motion is greatest, viz. betwixt the atlas and dentata; and it is there that Albinus counts his INTER-TRANSVERSALES CERVICIS, PRIORES, LATERALES, &c. The inter-transversales are wanting in the BACK, giving place to the ligaments, by which they are tied to each other, and to the ribs; but in the LOINS, the inter-transversales are again strong, for the lateral or twisting motions of the loins.

The muscles on the fore part of the head and neck will complete the catalogue of those belonging to the spine, and they are the chief antagonists to the muscles which I have been describing.

Rectus major. CXL. RECTUS INTERNUS CAPITIS MAJOR. — There are three muscles on each side, lying under the œsophagus, trachea, and great vessels, flat upon the fore part of the vertebræ; and this is the first and longest.

Or. 4 or 5 lower trans. process of cervic. vert. Although this be called rectus, it is oblique, and running rather on one side; for it arises from the transverse processes of the five lower vertebræ of the

neck, and it is inserted into the cuneiform process of the occipital bone, just before the foramen magnum. *In.* cuneiform process.

CXLI. RECTUS INTERNUS MINOR. — This is an exceedingly small muscle. It lies immediately under the RECTUS MAJOR: it arises from the fore part of the body of the first vertebra, the atlas, and going (like the other rectus) obliquely inwards, it is inserted into the occipital bone, near the condyle. Rectus minor internus. *Or.* fore part of the atlas. *In.* occipital bone near the condyle.

CXLII. And the RECTUS CAPITIS LATERALIS is another small muscle like the former, which arises from the transverse processes of the first vertebra, and is inserted into the side of the cuneiform process of the occipital bone. It lies immediately under the exit of the great jugular vein. Rectus cap. lateralis. *Or.* trans. process of the atlas. *In.* side of the cuneiform pro.

CXLIII. LONGUS COLLI. — This is the chief of those muscles which lie upon the fore part of the neck; it is very long, arising from the flat anterior surface of the vertebræ of the back, to go up along those of the neck. Longus colli.

Its origin is first within the thorax, from the three uppermost vertebræ of the back, from the flat part of their bodies, and then from all the transverse processes and bodies of the neck, except the three upper ones. It is inserted tendinous into the fore part of the second vertebra of the neck, where the opposite large muscles meet in one point almost.* *Or.* 1st, bodies of 3 upper dorsal vert. and 2d, bodies and trans. proc. of all the cerv. vert. excepting the 3 upper. *In.* body of dentata.

All these muscles, which lie thus flat upon the plain surface of the vertebræ of the neck, pull the head and neck directly forwards; or when one acts, they are of use in pulling it towards one side; though I rather suppose this motion is performed by the external muscles chiefly.

CXLIV. The SCALENUS I consider as one muscle; for it is one in origin, insertion, and office. Its origin is from the whole upper surface of the first rib, from its cartilage backwards, and also from the second rib; and its insertion is into the transverse processes of the vertebræ of the neck. But by its broad origin,

* The longus colli muscle is in part covered by the rectus major.

and its very long insertion, it gives opportunity for dividing it into several fasciculi; and accordingly it has been so divided; but these divisions are entirely modern, artificial, and unnatural. The ancients considered it as one triangular muscle: Winslow divided it into two, the primus and secundus; Cowper into three; Douglas into four; and Albinus divides it into five muscles. The ancients called it scalenus, from its resemblance to the scalene triangle; and the true anatomy is, to consider it as one great triangular muscle, flat, and stretching from the ribs to the neck, closing the thorax above, and giving passage to the nerves and vessels of the arm.

Scalenus anticus. *Or.* trans. proc. of 4th, 5th, and 6th cerv. vert. *In.* 1st rib near its cartilage. Scalenus medius. *Or.* trans. proc. of all the cerv. vert. *In.* large portions of 1st rib. Scalenus posticus. *Or.* trans. process of 4th, 5th, and 6th cerv. vert. *In.* 2d rib.

If it were to be described in distinct portions, it would be in three parts. The anterior portion arises from the transverse processes of the fourth, fifth, and sixth vertebræ of the neck, and is inserted into the flat part of the first rib hard by its cartilage. The middle portion from the transverse processes of all the vertebræ of the neck goes to the outer edge of the rib, and extends along all its length. The posterior portion arises from the transverse processes of the fourth, fifth, and sixth vertebræ. It is inserted into the upper edge of the second rib, about an inch or more from its articulation with the spine.

The first head is tendinous and fleshy at its insertion into the rib; but the second and third heads are tendinous, both in their origins and insertions.

The subclavian artery and the nerves pass in the interstice betwixt the first and second portions.

The office of the scalenus muscle is to pull the neck to one side, or to bend the head and neck forward, when both act; and when the neck is fixed backwards, they may perhaps raise the ribs; for asthmatics are observed to throw the head backwards, in order to raise the chest with greater power.

OF THE MUSCLES OF THE ABDOMEN AND OF THE DIAPHRAGM.

The abdominal muscles cover in the belly, contain the bowels, and take a firm hold upon the pelvis and the trunk. The diaphragm, again, is a moving partition betwixt the thorax and the abdomen, and the diaphragm pressing down the bowels upon the abdominal muscles, enlarges the thorax, and the abdominal muscles re-acting push the bowels back upon the diaphragm, and compress the thorax. Thus, the alternate yielding and re-action of the abdominal muscles and diaphragm perform breathing, agitate the bowels, promote the circulation, expel the fæces and urine, assist the womb in the delivery of the child; and, with all these important uses, the abdominal muscles bend and turn the trunk, and fix it for the stronger actions of the limbs. They steady the body in lifting weights, in bearing loads, in all our more violent exertions. They often give way under this double office of breathing and of straining, along with the rest of the body; and the bowels coming out through their natural openings, or by bursting through the interstices of their fibres, form herniæ of various kinds. Whence the anatomy of these muscles is most interesting to the surgeon.

The muscles of the abdomen are five on each side. 1. The outer oblique muscle, to which the names of DESCENDENS, DECLIVIS, and MAJOR are added, because it is the outermost of all the abdominal muscles, because it is the largest, covering all the side of the abdomen with its fleshy belly, and all the fore part of the abdomen with its broad expanded tendon; and it is called declivis, or descendens, because its fleshy belly begins above, upon the borders of the thorax, and because both its muscular and tendinous fibres, which lie parallel to each other, run obliquely from above downwards and inwards.

2. The OBLIQUUS INTERNUS is named from its being within the first, and has the names of ASCEN-

DENS vel MINOR superadded, because its fleshy belly is smaller than that of the first, arises below chiefly in the haunch-bone, and all its fibres go from below upwards.

3. The TRANSVERSALIS lies under all the others, and next to the cavity of the abdomen, and has but one name, which also is derived from the direction of its fibres running across or round the abdomen.

4. The RECTUS, so named because of its running on the fore part of the abdomen, in one straight line from the os pubis to the sternum.

5. The PYRAMIDAL muscle is the only one named from its shape. It is a small, neat, conical muscle, which arises from the os pubis, by a broad basis, and has its apex turned upwards; but it is not always found, for it is only as a supplement to the recti muscles, and as a part of them, whence it has been named MUSCULUS SUCCENTURIATUS, or supplementary muscle.

Obliquus externus descendens. Or. 8 inf. ribs.

CXLV. The EXTERNAL OBLIQUE muscle arises from the ribs, and, like all the others which arise from ribs, is a serrated muscle. It comes from the eight lower ribs, by distinct fleshy tongues, one from each rib. Four of these serræ are mixed with the indentations of the serratus magnus anticus muscle, which goes off in an opposite direction, and the rest with the origins of the pectoralis major and latissimus dorsi; indeed sometimes there is a mixing of the fibres of this muscle with those of the pectoralis major. The origin of the muscle, lying broad upon the border of the chest, is its thickest and most fleshy part, whence its fibres go down all in one direction, parallel with each other, but oblique with respect to the abdomen. Its fleshy belly ceases about the middle of the side, at the linea semilunaris. Its flat sheet of tendon goes over the fore part of the belly, till it meets its fellow exactly in the middle, so that one half of the back part of the abdomen is covered by its fleshy belly, and the fore part by its tendinous expansion.

In. 1. linea alba.

The muscle meets its fellow in the middle of the belly; and this meeting forms (along with the other

tendons) a white line from the pubes to the sternum, which is named LINEA ALBA. It also, before it reaches the middle, adheres to the flat tendon of the internal oblique. This meeting is about four inches on either side of the linea alba, and is a little inclined to the circular, whence it is named linea semilunaris. And, finally, this muscle is implanted into the spine of the ilium, fleshy about the middle of the ilium, tendinous at the fore part or spinous process of the ilium, and still tendinous into the whole length of that ligament, which extends from the spine of the ilium to the crest of the pubes.

2. spine of the ilium.

3. Poupart lig. 4. os pubis.

This is the whole of its insertions, viz. all the length of the linea alba, from the pubes to the sternum, the fore part of the spine of the ilium, and the ligament of Poupart, which, though it is commonly thought to be but the tendon of the external oblique stretching from point to point, is, in truth, a distinct ligament, independent of the tendon, and stronger than it.*

Obliquus internus.

CXLVI. OBLIQUUS INTERNUS ABDOMINIS. — The chief part of this muscle arises thick and fleshy from all the circle of the spine of the ilium, with its fibres directed upwards. But, to be accurate, we must describe it as arising from the whole length of the spine of the ilium, from the joining of the ilium and sacrum, from the spines of the sacrum itself, and from the three lower spinous processes of the loins †; and, lastly, it arises from nearly half of the ligament of the thigh, at its end next to the ilium; but still the chief belly is at the iliac spine. From that it spreads upwards in a radiated form; the central fibres only are direct, going across the abdomen to the linea alba; the higher fibres ascend and go towards the sternum, and the lower ones go obliquely downwards to the pubes. Its flat tendon is like that of the external oblique, and it is inserted into the

Or. 1. spine of the ilium, 2. the sacrum, and 3. the fascia lumborum. 4. half of Poupart's lig.

* See *post*, page 369.

† This origin from the spinous processes of the loins and sacrum is a thin tendon, common with the serratus posticus inferior and latissimus dorsi muscles.

In. 1. cartilago ensif. 2. cartilages of 7th and all the false ribs, 3. linea alba, 4. os pubis.

cartilages of the seventh and all the false ribs, into the ensiform cartilage of the sternum, and into the linea alba, through its whole length, and the os pubis.*

Transversalis abdominis. *Or.* 1st, the 7 lower ribs, 2d, trans. process of last dorsal vert. 3d, the four trans. processes of the lumbar vert. *In.* 1. cartilago ensif. 2. linea alba, and 3. os pubis.

CXLVII. The TRANSVERSALIS ABDOMINIS forms the internal layer, it runs directly across the belly. It arises fleshy from the inner surface of the seven lower ribs, where its digitations mix with those by which the diaphragm arises; tendinous from the transverse processes of the four lower lumbar vertebræ, and last of the back; from the whole spine of the os ilium internally, and from a part of the Poupart ligament. Upon the whole its origin is like that of the inner oblique muscle; its fibres go across the abdomen, and its tendon is inserted into the sheath of the rectus, the whole length of the linea alba, cartilago ensiformis, and os pubis.

The succession in which these three muscles arise from the chest is this: the external oblique muscle lies broad upon the outside of the chest, and so its tongues mix with the tongues of the serratus anticus magnus. The internal oblique muscle again rises lower down the thorax, from its edge, from the cartilages of the ribs. The transverse muscle arises within the thorax, from the internal surface of the ribs, opposite to where the tongues of the external oblique lie; and the diaphragm arising from the same ribs, mixes its indigitations with the transversalis, so that Gaspar Bartholin, observing this indigitation to be very curious in the larger animals, believed the diaphragm and transverse muscles to be but one great trigastric or three bellied muscle, surrounding all the abdomen. But the transversalis, with the other abdominal muscles, are the antagonists of the diaphragm.

Rectus.

CXLVIII. The RECTI muscles cover the abdomen on its fore part, in a line from the pubes to the sternum; and they belong so equally to the sternum and to the os pubis, that it is indifferent which we call

* See the description of the sheath of the rectus muscle, *post*, p. 366.

Or. first, from 3 inf. true ribs, 2d, ensif. cart. of sternum.

In. symphysis pubis.

their origin, and which their insertion. The origin (as I should call it) of each rectus muscle is in the sternum, is broad and fleshy, lies upon the outside of the sternum, covering part of it, and all the xiphoid cartilage, and touching and mixing its fibres with the great pectoral muscle, and likewise taking part of its origin from the cartilages of three of the ribs. It is about four inches broad all down the abdomen, and terminates at the side of the symphysis pubis, with a flat and pointed tendon about an inch in length, and about an inch broad. This muscle is crossed at intervals by four tendinous intersections, which divide it into five distinct bellies. Commonly there are three bellies above the umbilicus, and two below; but the recti muscles are the least regular of all the muscles of the abdomen. Vesalius, Albinus, and Sabatier were thought to have found the recti abdominis extending up to the throat. But it is now found that Vesalius had only represented the muscles of a monkey, or of a dog, which are very long, upon the thorax of a human subject. Sabatier, upon revising his notes, retracts what he had said: and Albinus also is supposed to have seen only a production of the mastoid muscle extending down the breast; for irregularities of this kind have been found.

Pyramidalis.

Or. crest of the os pubis.
In. linea alba.

CXLIX. The PYRAMIDAL muscles are as a supplement to the recti. There is a small neat pyramidal muscle on each side, or rather a triangular muscle, fleshy through its whole extent and length, with its base turned towards the pubes, and its apex towards the umbilicus; so that its origin is in the crest of the pubes, and its pointed insertion in the linea alba: and though the recti muscles have been supposed by Massa to relate to the penis, or by Fallopius to belong to the urinary bladder, their true use is only to assist the rectus to draw down the sternum, and tighten the linea alba, and so to give greater power to the oblique and transverse muscles. The pyramidalis is so irregular a muscle, that sometimes two are found on one side, and none at all on the other. Sometimes two on each other; sometimes there is but

one, and very often they are wanting, the belly of the rectus coming quite down to the pubes.

The effects of the abdominal muscles in moving the trunk cannot be mistaken. The RECTI pull the ribs downwards in breathing, flattening the belly, and bending the body forwards. The two OBLIQUE MUSCLES of one side acting, turn the trunk upon its axis; but the oblique muscles of the opposite side acting, co-operate with the rectus in flattening the belly and bending the body; and the TRANSVERSE MUSCLES tighten the linea alba, so as to give effect to all the others; and particularly they brace the sheath of the recti muscles, so as to give them their true effect.

1. The LINEA ALBA is the common meeting of all the thin flat tendons, and therefore we call it their insertion, being the common point towards which they all act; it is white, by the gathering of all the colourless tendons.

2. The LINEA SEMILUNARIS is a line of the same white appearance, of a circular form, and produced by the meeting of all the tendons on the edge of the rectus muscle, to form a sheath for it.

3. The SHEATH for the RECTUS MUSCLE does not admit of so brief a definition as this: it has been commonly supposed to be formed in a very curious manner, chiefly by the broad tendon of the obliquus internus, which being the central muscle, betwixt the two other layers, is supposed to have its tendon split into two thin sheets; that the outermost sheet adheres to the outer oblique muscle, forming the outer part of the sheath, while its inner sheet adheres to the tendon of the transverse muscle, forming the inner part of the sheath; but this is too intricate, and can hardly be proved by dissection. Cowper expresses his doubts about this doctrine of the tendon of the inner oblique muscle being split into two layers; and I think the truest description is this, that all the tendons meet, and adhere to the semilunar line; that they immediately part and form this sheath; that the flat tendons of both the oblique

muscles go upon the outer surface of the rectus to form that side of the sheath; that the tendon of the transverse muscle only lies under the rectus, forming the lower part of the sheath, and that it is unassisted by any lamella of the inner oblique muscle; that the sheath is complete at the fore part, or over the muscle; but that under the muscle the sheath stops about five or six inches above the pubes, and that there the recti muscles (or in their place the pyramidal muscles) lie bare upon the viscera, lined only by some scattered fibres of the fascia transversalis and the peritonæum.* And that this back layer of the sheath is thinner and more delicate, and but little attached to the back part of the rectus muscle, which is easily raised in dissection, while the fore part of the sheath adheres firmly to the fore part of the muscle, forming those cross bands or tendinous intersections which divide the rectus into bellies, and the sheath where it lies over the muscle cannot be dissected without a degree of violence, either to the sheath, or to these tendinous intersections.

4. The UMBILICUS is that opening in the centre of the abdomen, in the middle of the linea alba, through which the nutritious vessels of the fœtus pass. The vessels have degenerated into ligaments in the adult, and the umbilicus is closed in the form of a ring; but sometimes it is forced by violent action, and the viscera come out by it, forming umbilical hernia.

5. The RING of the ABDOMINAL MUSCLES is that opening near the lower part of the abdomen, just over the pubes, through which the spermatic cord passes in men, and the round ligament of the womb in women.

Cowper (p. 5.) says that the spermatic cord passes through separate rings, in each of the three abdominal muscles; and, like older authors, he makes nature

* Cowper had never observed this but once, that the lower part of the rectus was not lined by the tendon of the transversalis. He concluded that in this instance it was a sporting of nature; "so much a lusus naturæ, that accidents like this might be the cause of certain ruptures."

exceedingly wise, in placing the rings not opposite to each other, but one high, and another lower, and a third lower still, so as to prevent the bowels falling out. But the truth is, that neither the internal oblique nor the transverse muscles have any share at all in the ring, which belongs entirely to the external oblique muscle, and is formed in this way: all the tendinous fibres of the external oblique are, like the muscle itself, oblique, running from above downwards; and the tendinous fasciculi are in some places wider, a little disjoined from each other, and resembling stripes, crossed by small threads of tendon, as if the long fibres were in danger of parting from each other, so as to leave a gap, and were held together by these cross threads; and it is, in fact, a wider and perfect separation of two fibres that forms the ring, and a stronger interlacement of cross fibres that secures it from splitting farther up. But the chief security of the ring is by the form of the opening; for it is not a ring, as we call it, but a mere split in the tendon, which begins about an inch and a half above the pubes, is oblique, and looking towards the pubes, like the fibres which form it, and consists of two legs, or pillars of the ring, as they are called; for the upper slip, which forms the upper part of the opening, goes directly towards the crest or highest point of the pubes; the lower pillar, or the slip which forms the lower line of the slit, turns in behind, gets under the upper one, and is implanted into the pubes, within and behind the upper pillar: this lower slip forms at once the lower pillar of the ring and the edge of the femoral ligament. But Cowper was not far from the truth, when he said the bowels were prevented from falling down by the obliquity of the spermatic passage. The spermatic cord is flat and spread out when it begins to pass down through the abdominal walls, and it is only when it has emerged from this proper ring that it assumes the round and cord-like form. Besides, it comes out under the transversalis muscle considerably higher up and more towards the ilium than the ring, and in its further descent it splits the fas-

ciculi of the internal oblique muscle, and carries one of these fasciculi along with it, which constitutes the cremaster muscle. First its veins and arteries are gathered together, then it is joined by the vas deferens, and, finally, it is embraced by the cremaster muscle; and thus perfected, as it were, it glides obliquely through the ring of the external oblique muscle. Where it comes out it is covered by the fascia superficialis, a process of which goes down upon the cord. When the cord is passing under the transversalis muscle it passes the fascia transversalis, the fibres of which are strong upon one side: the cellular membrane too here is dense, and, although there be in the natural condition of the parts no proper ring, yet when a *rupture* takes place, a portion of the peritoneum is thrust through the spermatic passage, and presses the cellular membrane and fascia so together, that a ring is formed; this is what is meant by the INTERNAL RING.

Cremaster. *Or.* 1. lower edge of intern. obliq. 2. the os pubis. *In.* tunica vaginalis.

CL. The CREMASTER MUSCLE of the TESTICLE, which is a thin slip of fibres from the internal oblique muscle of the abdomen, designed for suspending the testicle, and for drawing it up, is very thick and strong in the lower animals, as in bulls, dogs, &c.; is easily found in man, but not always, being sometimes thin and pale, and hardly to be known from the coats upon which it lies. It appears to grow more fleshy in old age, and to be thickened in enlargements of the testicle, the better to support the weight.

Crural arch.

6. The LIGAMENT of the THIGH * is a distinct ligament, and not merely the tendon of the external oblique, rounded and turned in. It passes from the ilium obliquely across to the pubis. It receives the external oblique muscle, for the tendon is implanted into it. Part of the flesh of the internal oblique muscle and transversalis arise from the outer end of the ligament. It forms an arch over the psoas and

* This ligament of the thigh is named also the INGUINAL LIGAMENT; the CRURAL ARCH; the LIGAMENT of POUPART; the LIGAMENT of FALLOPIUS, &c.

iliacus internus muscles, where the crural artery vein and nerve pass out, and it is tied down at both sides of the passage for the vessels by the fascia of the thigh. But this ligament requires a more particular description. It appears outwardly to have a round edge, but in fact it is here turned in, its lower margin shelves inwards, and at the pubic end it spreads horizontally upon the os pubis, as far as to the brim of the true pelvis, and the spermatic cord lies upon it. The angle where it turns inwards is attached to the fascia of the thigh, while the edge, which is turned in, is continued inwards under the cord in the form of a fascia or ligament, and is connected with the linea ilio-pectinea. So this ligament of the thigh is said to have three principal attachments to bone, viz. the anterior superior spinous process of the ilium, the spine of the os pubis, and the linea ilio-pectinea. The attachment of the ligament to the fascia of the thigh demands a little more attention. When the glands and fat of the groin are taken away, the connection of the fascia of the thigh and the Poupart ligament presents the form of an inverted funnel; and if an attempt be made to pass the finger to the bottom of it, towards the abdomen, it is stopped by a strong net-work of fibres: the meshes of this net-work permit the lymphatics of the thigh to pass upwards, whilst the stronger processes of the fascia take the form of a crescent. Thus, besides the proper strong Poupart or inguinal ligament, there is an arch or crescent formed of less dense and shining substance, which goes down from the edge of the ligament, and terminates on each extremity in the fascia of the thigh. This is the part under which the crural hernia comes out; round which, indeed, the tumour turns, and it is the sharp edge of this crescent which nips, and causes the strangulation of this kind of hernia.

It often happens, that in vomiting, in violent coughing, in straining at stool, or in lifting heavy weights, the natural openings are forced, and the bowels descend. The UMBILICUS is very seldom forced by sudden exertion, for it is a very firm ring;

but it is slowly dilated in pregnancy, and hernia of the navel is infinitely more frequent with women than with men. The opening of the RING is often kept dilated by the bowels following the testicle when it descends, forming the congenital hernia; most frequently of all, the ring is forced in strong young men by hard and continued labour, or by sudden straining; but women are safer from this kind of hernia, because the round ligament of the womb is smaller than the spermatic cord, and the ring in them is very close. — ABDOMINAL VENTRAL HERNIÆ are those which come not through any natural opening, but through the interstices of the muscles, or their tendons; sometimes hernia follows a wound of the abdomen; for a wound of the abdominal muscles may not heal so neatly as not to leave some small interstice, through which the bowels protrude. Thus, any point may be forced by violence; any of the openings, or all of them, may be relaxed by weakness, as in dropsical or other lingering diseases: for it is from this cause that herniæ are more frequent in childhood and in old age, by the laxity which is natural to childhood, or by the weakness natural to the decline of life. Often there seems to be a hereditary disposition to herniæ in certain houses, the form of the openings of the abdomen being wider in a whole family, just as the features of the face are peculiar. And I have seen a child with all these openings so particularly wide, that upon the slightest coughing or crying, herniæ came down at every possible point, at the navel, the scrotum, the thigh, and in the sides of the abdomen, all at once; or as one tumour was reduced another arose.

CLI. The DIAPHRAGMA is a Greek word, translated inter-septum, the transverse partition betwixt the abdomen and the thorax, the midriff; but it is not merely a transverse partition, it is a vaulted division betwixt the thorax and abdomen; and not only is the middle raised into a vaulted form, but its obliquity is such, that though its fore part be as high as the sternum, its lower and back part arises near the pelvis from the lowest vertebra of the loins. Diaphragm.

It is a circular muscle, which is fleshy towards its borders, and tendinous in the centre; which is convex towards the thorax, and concave towards the abdomen; becoming plain, or almost so, when it presses against the abdominal muscles in drawing the breath; and returning to its convex form, when the abdominal muscles re-act in pushing it back into the thorax.

Greater muscle.

The diaphragm arises, by one broad fleshy attachment, from all the borders of the chest, forming the upper or greater muscle of the diaphragm; and it arises below, by many small tendinous feet from the fore part of the loins, which meeting, form what is called the lesser muscle of the diaphragm. 1st, The GREAT OF UPPER muscle arises, first, from under the xiphoid cartilage, and from the lower surface of the sternum. 2dly, From all the false ribs; from the cartilage of the seventh, eighth, and ninth ribs; and from the bony parts of the tenth and eleventh ribs, and from the tip of the twelfth rib. All these origins are, of course, fleshy digitations or tongues which intermix with those of the transverse muscle of the abdomen. 3dly, From the tip of the twelfth rib to the lumbar vertebræ, there is a ligament extended, which, going like an arch over the psoas and quadratus lumborum muscles, is named LIGAMENTUM ARCUATUM; and from this another part still of the great muscle of the diaphragm arises. Thus, the upper muscle of the diaphragm has four chief origins, viz. from under the sternum and xiphoid cartilage; from all the false ribs; from the ligamentum arcuatum; and, in short, from all the borders of the chest, from the xiphoid cartilage quite round to the vertebræ of the loins.

Or. 1. xiphoid cart.

2. seventh and all the false ribs,

3. the lig. arcuatum. In. cordiform tendon.

Lesser muscle.

2. The LESSER MUSCLE of the DIAPHRAGM, which arises from the spine, begins by four small slender tendinous feet on each side. The first of these, the longest one, arises from the second vertebra above the pelvis: it goes from the flat fore part of its body, and adheres to the fore part of the third and fourth lumbar vertebræ as it mounts upwards. The second rises from the third vertebra, but farther out towards the side

Or. 2d, 3d, and 4th lumb. vert.

In. back part of cordiform tendon.

of the vertebra. The third arises from the side of the fourth vertebra. And the fourth tendon of the diaphragm arises from the transverse process of the same fourth vertebra of the loins. But indeed we ought, in place of this minute demonstration, to say, that it arises from the four uppermost lumbar vertebræ by four tendinous feet, flat and glistening, and adhering closely to the shining ligament with which the bodies of the vertebræ are strengthened; that these tendons soon join to form two strong round fleshy legs, which are called the crura diaphragmatis; of which crura, the left is the smaller one: and these crura having opened to admit the aorta betwixt them, and then joining, mixing, and crossing their fibres, form a fleshy belly, the lesser muscle of the diaphragm.

3. The TENDON in the centre of the diaphragm is determined in its shape by the extent of these fleshy bellies; for the great muscle above almost surrounds the central tendon. The smaller muscle below meeting it, the two divisions give it a pointed form behind; the tendon has the figure of a trefoil leaf, or of the heart painted upon playing cards. The middle line of this tendinous centre is fixed by the membrane which divides the thorax into two; the two sides go upwards into the two sides of the chest, each with a form like the bottom of an inverted basin: their convexity reaching within the thorax, quite up to the level of the fourth true rib: the proper centre of the diaphragm is fixed by this connection with the mediastinum, that its motion might not disorder the actions of the heart, which rests upon this point, and whose pericardium is fixed to the tendon: but the convexity of either side descends and ascends alternately as the diaphragn contracts, or is relaxed; so that it is chiefly these convexities on either side which are moved in breathing.

Thus is the diaphragm composed of one great and circular muscle before; of one smaller circular muscle behind; and of the triangular tendon, as the centre betwixt them: and, both in its fleshy and tendinous parts, it is perforated by several vessels

passing reciprocally betwixt the thorax and the abdomen.

First, The AORTA, or great artery of the trunk, passes betwixt the crura or legs of the diaphragm, which, like an arch, strides over it to defend it from pressure. The thoracic duct passes up here also.

Secondly, The ŒSOPHAGUS passes through the diaphragm, a little above this, and to the left side: its passage is through the lower fleshy belly, and through the most fleshy part of the diaphragm: and the muscular fibres of the crura diaphragmatis first cross under the hole for the œsophagus; then surround it; then cross again above the hole; so that they form the figure of 8; and the œsophagus is so apparently compressed by these surrounding fibres, that some anatomists have reckoned this a sort of sphincter for the upper orifice of the stomach.

Thirdly, The great VENA CAVA goes up from the abdomen to the heart, through the right side of the diaphragm; and this hole being in the firm tendon, there is no danger of strangulation, or of the blood being impeded in the vein.

The tendon is composed of fibres which come from the various fasciculi of this muscle, meeting and crossing each other with a confused interlacement, which Albinus has been at much pains to trace, but which Haller reports much more sensibly: "Intricationes variæ et vix dicendæ;" irregular and confused, crossing chiefly at the openings, and especially at the vena cava, the triangular form of which seems to be guarded in a most particular way.

The lower surface of the diaphragm is lined with the peritonæum, or membrane of the abdomen; and the upper surface is covered with the pleura, or membrane of the chest. The hole for the vena cava is so large that the peritonæum and pleura meet, and nearly touch each other through this opening, all round the vein.

The chief use of the diaphragm is in breathing, and in this office it is so perfect, that though there be a complete anchylosis of the ribs (as has often

happened), the person lives and breathes, and never feels the loss. The diaphragm is in its natural state convex towards the thorax; when it acts, it becomes plain, the thorax is enlarged, and by the mere weight of the air, the lungs are unfolded, and follow the diaphragm. No vacuum is ever found betwixt the diaphragm and the lungs: but the lungs follow the ribs and diaphragm as closely as if they adhered to them: and indeed when they do adhere, it is not known by any distress. So we draw in the breath, and when the abdominal muscles re-act, the diaphragm yields, goes back into the thorax, and grows convex again, by which we blow out the breath; and while the diaphragm is acting, the abdominal muscles are relaxed, yield, and are pushed out, and leave the ribs free, to be raised by their levator muscles. And again, when the abdominal muscles re-act, the diaphragm in its turn yields so, that they at once force up the diaphragm, and pull down the borders of the thorax, assisting the serrated muscles which depress the ribs.

There is also in every great function, such a wonderful combination of actions conspiring to one end, as cannot be even enumerated here. But the alternate action and re-action of the abdominal muscles draw in and expel the breath, promote the circulation, and gently agitate the bowels, while their more violent actions discharge the fæces and urine, and assist the womb; and vomiting, yawning, coughing, laughing, crying, hiccup, and the rest, are its stronger and irregular actions. The diaphragm might well be named by Haller, "Nobilissimus post cor musculus." And Buffon, who affected the character of anatomist with but little knowledge of the human body, might mistake its central tendon for a nervous centre, the place of all emotions, and almost the seat of the soul. For the ancients confounded the names and ideas of tendon and nerve. And, in sickness and oppression, lowness and sighing, in weeping or laughing, in joy or in fear, all our feelings seem to concentrate in this part.

THE MUSCLES OF THE PARTS OF GENERATION, AND OF THE ANUS, AND PERINÆUM.

The muscles of the perinæum and parts of generation follow the division of the abdominal muscles more naturally than any other. On looking to the skeleton, we see that the viscera of the abdomen and pelvis would fall out from the lower opening, if this space was not guarded in a particular manner. It is therefore closed, 1. by fascia; 2. by muscles, now to be enumerated; and 3dly, by fat and cellular texture; the nature and quantity of which is a matter of no mean interest to the surgeon.

Before reading the account of the muscles of the perinæum, the reader should peruse that part of the last volume which treats of the structure of the penis, &c.

Fascia, or aponeurosis. — Before dissecting the muscles of the perinæum, the student should examine that web of membrane which covers them. It comes across from the tuberosity and ramus of the ischia, and, running forward, terminates at the scrotum. It is a subject very important to the operating surgeon.

Erector penis.

CLII. The erector penis is a delicate and slender muscle, about two inches in length. It lies along the face of the crus penis on each side. And when the crura penis are inflated, the erectors are seen of their proper length and form. The erector of each side rises by a slender tendon from the tuberosity of the os ischium. It goes fleshy, thin, and flat, over the crus penis, like a thin covering. It ends in a delicate and flat tendon, upon the crus penis, about two inches up; and the tendon is so thin and delicate, that it is hardly to be distinguished from the membrane of the cavernous body.

Or. tuber. of the ischium.
In. sheath of the crus penis.

The erectors lying thus on the sides of the penis, have been called collaterales penis, or ischio-

CAVERNOSI, from their origin in the ischium, and their insertion into the cavernous bodies.

CLIII. The TRANSVERSALIS PERINÆI is often named transversalis penis; but its origin being in the tuberosity of the os ischium, by a delicate tendon, and its insertion into the very backmost point of the bulb of the urethra, where it nearly touches the anus, and where there is a meeting of several muscles, its course is directly across the perinæum, and its relation to the perinæum and anus is very direct and evident, while its relation to the penis is rather doubtful. Often there is a second muscle of the same origin and insertion, running like this, across the perinæum, named TRANSVERSALIS PERINÆI ALTER.*

Transversalis. Or. tuber. of the ischium. In. common centre of union.

This transverse muscle may, by bracing up the bulb to the arch of the pubis, have some effect in stopping the vein on the back of the penis, and so producing erection; but its chief use must be in preventing the anus from being too much protruded in discharging the fæces, and in retracting it when it is already protruded.

CLIV. The EJACULATOR muscle is not a single muscle, as it is often described. It is manifestly a pair of muscles surrounding the whole of the bulb of the urethra. They arise on each side from the side of the bulb, and crus of the penis, and from the triangular ligament of the urethra. From their arising from this ligament, they have been frequently described as arising from the ramus of the pubes. There is along the lower face of the bulb a white

Ejaculator

Or. side of the body and bulb, and triang. fascia.

* There is a great irregularity in this muscle. There is very frequently a slip called transversalis alter, which, however, would be better named obliquus. In some bodies the transversalis is hardly perceptible, while in others it is very strong: there is also a great variety in the size of it, on comparing the two sides of the same body: thus we see frequently in Lascars and Negroes, that on one side there is a very large muscle, while on the other there is a small transversalis, and a large obliquus.

We may also frequently see a muscle, the transversalis profundus; it has exactly the same origin and insertion with the other, but lies deeper. At first view it appears to be part of the levator ani, but the fibres run directly across, while those of the levator run in a descending direction.

In. middle of the bulb, and spongy body. and tendinous line, corresponding with the outward line or seam of the perinæum. This line distinguishes the bellies of the two muscles, and is formed by their tendinous insertions; or sometimes this central line is considered as the origin of the muscle: in that case, the fibres of each side surround their proper half of the bulb with circular fibres, winding obliquely round the bulb; and each muscle ends in its separate tendon, which is delicate and small, and which, leaving the bulb of the urethra, turns off obliquely to the side, so that the tendon of each side goes out flat and thin upon the crus penis of its own side, a little higher than the insertion of the erector penis. We know and feel its convulsive, involuntary action in throwing out the seed; and we are conscious that we use it as a voluntary muscle in emptying the urethra of the last drops of urine.

Sphincter ani. *Or. os coccygis.* *In. 1. round the anus, 2. spongy body of the urethra, and 3. common angle of union.*

CLV. The SPHINCTER ANI muscle is a broad circular band of fibres, which surrounds the anus. It arises from the point of the os coccygis behind. It sends a neat small slip forwards, by which it is attached to the back part of the ejaculator muscle; but the great mass of the muscle is inserted into the common angle of union of the ejaculator, transversales, and this muscle. It is of a regular oval form, and is, for a very obvious reason, stronger in man than in animals. Some choose to enumerate two sphincter muscles, of which this is the external, or cutaneous; what they describe as the internal one, is merely the circular fibres, or muscular coat of the intestine, strengthened considerably towards the anus, but not a distinct muscle. Its effect is to shut the anus.

Levator ani. *Or. 1. os pubis, thyroid hole, 2. the spine and body of the ischium.*

CLVI. The LEVATOR ANI muscle is described as a pair of muscles, one from each side; but it is properly one broad and thin muscle, which arises from the internal surface of all the fore part of the pelvis, and, from its breadth, it has been named MUSCULUS ANI LATUS. It continues its origin from the internal surface of the pubes, from the edge of the foramen thyroideum, from the thin tendinous

sheath that covers the obturator internus and coccygeus muscles, and from the body and spine of the os ischium. It grows gradually smaller, as it goes downward to surround the anus. So it is inserted into the circle of the anus, into the point of the os coccygis, and is mixed with the sphincter ani muscle. The whole pelvis is lined with it like a funnel, or inverted cone, the wider part representing its origin from the pelvis, the narrower part its insertion into the anus. The whole bladder is surrounded, and covered by this muscle; the urethra passes through a split in its fibres, and no operation of lithotomy can reach the bladder from below, without cutting through this muscle. It raises the anus, and at the same time dilates it, opening the anus for the passage of the fæces, and supporting it, so as to prevent its being protruded. Thus, it is not for shutting the anus, as some have supposed, but is the direct antagonist of the sphincter ani muscle. By enclosing the bladder, the levator ani acts upon it also; for the neck of the bladder passing through a slit in its fibres, while the levator ani is acting, this slit is drawn, as it were, round the neck of the bladder, and so the urine is for the time prevented from flowing. It is as a sphincter to the bladder, which prevents our passing the urine and fæces at the same moment. By surrounding the lower part of the bladder, and enclosing the prostate gland, and the vesiculæ seminales, which lie upon the back of the bladder, this muscle affects these parts also, and is, perhaps, the only muscle which may be supposed to empty the vesiculæ, or to compress the gland, pulling upwards at the same time, so as to press the back of the penis against the pubes, to maintain the erection, and to assist the accelerator muscles. By enclosing the bladder, vesiculæ, prostate, and anus, this muscle produces that sympathy among the parts, which is often very distressing, as in gonorrhœa, the stone in the bladder, constipation, piles, and other diseases of these parts; for piles, constipation, or any cause which may excite the action of the levator muscles.

Fig. 1. verge of the anus, and 2. the two last bones of the os coccygis.

will cause erections, a desire to pass the urine, and an obstruction in the discharge of it.*

Coccygeus. *Or.* spine of the ischium and the ligament. *Ins.* side of the os coccygis.

CLVII. The MUSCULUS COCCYGEUS is a thin, flat muscle, which arises by a narrow point, from the inside of the pelvis, at the spine of the os ischium; is implanted, expanded and fleshy, into the whole length of the os coccygis; can be useful only by pulling up the point of the os coccygis; which is just equivalent to raising the circle of the anus; so that from every circumstance of its form and use, it might be fairly enough described as being merely the back part of the levator ani muscle.

The perinæum, where the bulb begins, is the point into which all the muscles are united; for the ejaculator muscle, and the sphincter ani muscle, touch at the beginning or point of the bulb; and a small pointed slip of the sphincter ani, going upon the bulb, connects them firmly together. The transversales perinæi come across the perinæum from either side; and the levator ani muscle comes down to meet the sphincter, so that the sphincter ani, the levator ani, the transversalis perinæi, and the ejaculator muscles, all meet in one point, viz. the back of the bulb. They secure the perinæum, and support the heavy viscera of the abdomen; if they be unskilfully cut in performing lithotomy, it will be difficult to extract the stone. In that operation, the incision passes by the side of the anus, and on the inside of the tuber ischii; and our knife accordingly cuts clean across the transverse muscles, which stand as a bar across the perinæum; it passes by the side of the erector muscle, need not touch it, or touches it slightly, and by a sort of chance: it must not touch

* There is a muscle described by Mr. Wilson, as a levator, or compressor urethræ. The origin of this muscle is from the arch of the pubes, and its fibres run round the membraneous part of the urethra, being inserted on the lower part into each other: it is situated between the Cowper's gland and the levator ani, being separated from the last muscle by a thin fascia, and some small veins. In order to make out this muscle distinctly, and with as large a tendon as Mr. Wilson describes it, it is necessary to sacrifice several of the fasciæ.

the ejaculator muscle; for whoever says he cuts the ejaculator, cuts too high, and performs his operation ill.* After the first incision we get deep into the pelvis, and cut the levator ani. The surgeon does not observe these muscles, on account of any danger which may attend wounds of them, but takes them as marks for the true place of his incision; and a good operator will be careful to have them fairly cut, that they may be no hindrance to the extraction of the stone.†

We find, of course, a difference in the muscles in the female perinæum. There is an erector clitoridis, which has the same origin as in the male, and it is inserted into the crura clitoridis, in the same manner that the erector penis is inserted into the crura penis. The next muscle is the sphincter vaginæ, which is a large muscle, taking an origin from the sphincter ani and posterior side of the perinæum; it is inserted into the union of the crura clitoridis. We find, likewise, a transversalis, which, though taking the same origin as in the male, is a very small muscle; its insertion is into the union between the sphincter vaginæ and sphincter ani: in the two next muscles, viz. sphincter ani and levator ani, there is no difference, except that they are attached to the vagina instead of the penis.

The muscles of the FEMALE PERINÆUM, are,

ERECTOR CLITORIDIS.—*Or.* From the ramus of the os ischium: in its ascent it covers the crus of the clitoris, as far up as the os pubis.

In. Into the upper part of the crus, and body of the clitoris.

* Those anatomists who describe the origin of the ejaculator to be from the ramus ischii object to this.

† The Detrusor Urinæ is but the muscular coat of the bladder; the Sphincter Vesicæ is but a denser fasciculus of this common coat of the bladder. I should no more think of describing them here than of describing the coats of the intestines or stomach. These muscles of internal parts, with the muscles of the internal ear, &c. I reserve for that part of the system which describes the organs and viscera.

Use. To erect the clitoris, by pushing the blood into its cavernous substance.

Sphincter vaginæ. — *Or.* From the sphincter ani and from the posterior side of the vagina, near its external orifice, opposite to the nymphæ, and covers the corpus cavernosum vaginæ.

In. Into the body, or union of the crura clitoridis.

Use. Contracts the mouth of the vagina, and by compressing the corpus cavernosum, pushes the blood into the clitoris and nymphæ.

Transversalis perinæi. — *Or.* As in the male, from the fatty cellular membrane which covers the tuberosity of the os ischium.

In. The upper part of the sphincter ani, and into a white tough substance in the perinæum, between the lower part of the pudendum and anus.

Use. To sustain the perinæum.

Sphincter ani. — *Or.* As in the male, from the skin and fat surrounding the extremity of the rectum.

In. Into the white tough substance in the perinæum, and below, into the front of the os coccygis.

Levator ani. — *Or.* As in the male, within the pelvis. It descends along the inferior part of the vagina and rectum.

In. Into the perinæum and sphincter ani.

MUSCLES OF THE THIGH, LEG, AND FOOT.

MUSCLES MOVING THE THIGH-BONE.

The muscles belonging to the thigh-bone arise all from the pelvis or trunk. The psoas magnus, and iliacus internus, come from within the pelvis, at its fore part, and, passing under the femoral ligament, go down to be implanted into the trochanter minor; and by this obliquity of their insertion, they turn the toes outwards, and bend the thigh. Other

muscles come from the lower and fore part of the pelvis, as the PECTINALIS, TRICEPS, and OBTURATOR EXTERNUS, which arise from the arch of the os pubis, and go down to be implanted into the linea aspera and lesser trochanter; and, they pulling the thigh towards the body, are called the ADDUCTORS. Others arise from the sacrum and back part of the pelvis, as the GLUTÆI, which, coming directly forwards to be implanted into the greater trochanter, pull back the thigh; and a fourth set coming also from the internal surface of the pelvis; viz. the OBTURATOR INTERNUS and the PYRAMIDALIS come out through the back opening, turn round the pelvis, as round a pulley, and roll the thigh, and draw it back. This completes the catalogue of those muscles which move the thigh.

1. The PSOAS MAGNUS, ILIACUS INTERNUS, PECTINEUS, TRICEPS, OBTURATOR EXTERNUS, which, coming from before, are inserted into the line of the minor trochanter and the femur, and bend the thigh.

2. The GLUTÆI, GEMINI, PYRIFORMIS, OBTURATOR INTERNUS, and QUADRATUS, which come from behind, are implanted into the line of the great trochanter, and extend the thigh; and it hardly need be remembered, that as, when the arms being fixed their muscles raise the weight of the body, as in climbing or in turning over a bar, by grasping with the hands, so the muscles of the thigh move that thigh only which is loose, and free from the weight of the body, while the muscles of the other thigh, which is fixed by the weight of the body, move not the thigh, but the trunk upon the thigh; so that our walking is performed not so much by the muscles of the thigh moving the limb, as by their moving the pelvis, *i. e.* rolling the trunk upon the limb.

MUSCLES MOVING THE THIGH.

1. The thigh is moved backwards and outwards.

By the glutæus maximus,	which are implanted into the	linea aspera,
——— medius,		trochanter major,
——— minimus,		top of trochanter.

2. The thigh is moved backwards, and rolled upon its axis,

By the pyriformis,	which are implanted into the	root of the trochanter,
gemini,		———
obturator externus,		———
——— internus,		———
quadratus,		betwixt the trochanters.

3. The thigh is moved forwards, and the toe pointed outwards,

By the psoas magnus,	which are inserted into the	trochanter minor,
iliacus internus,		———
pectinalis,		linea aspera.
triceps,		———

In the dissection of these muscles, a sort of artificial arrangement may be made of the muscles of the thigh, by taking off the fascia, the fascialis muscle, the sartorius, and the gracilis, and then dividing the remaining twelve muscles into groups of four; as, four inserted into the patella, to extend the leg; four to bend the leg, and four adductors to bring the thighs together.

OF THE FASCIA OF THE THIGH.

The thigh is enclosed in a very strong sheath, which, like that of the arm, sends down among the muscles strong tendinous septa or partitions, and the muscles are enclosed in these septa, and supported by them. The tendinous fascia of the thigh arises chiefly from the spine of the ilium, and from the Poupart ligament. Every fascia has something added by each muscle, and takes a new increase and adhesion at each bone which it passes. It is always strengthened by adhesions to joints, and comes down from them thicker upon the muscles below; and so this fascia of the thigh, which arises chiefly from the spine of the ilium, descends, covering all the muscles of the thigh: it sends partitions down to the linea aspera and trochanters; it has a new adhesion and a new source of tendinous fibres at the knee; it adheres most remarkably at the inner side

of the tibia, and then descends to the calf; it covers all the leg, and is again reinforced at the ancle; and this is a juster history than the common idea of making it an expansion of the small tendon of the small muscle which I am now to describe; for the fascia is too essential to the strength of the leg, and would be found there, though this muscle were away, as is the case with the palmar expansion.

This fascia rightly consists of two plates; one is that which comes down from the crest of the ilium and from the muscles of the belly; the other, that which arises purely from the tendon of the musculus fascialis, and which is at the same time connected with the capsular ligament of the femur and with the trochanter; and so the muscle called FASCIALIS lies betwixt the two plates of the fascia; and as the fascia, at this part, takes at least a reinforcement from the capsular ligament and from about the trochanter major, the fascialis muscle may be said to be inserted into the trochanter.

So this great tendinous fascia has these connections: the crest of the ilium; the ligament of Poupart, at the rim of the belly; the crest and arch of the os pubis; the tuber ischii, and so back along the coccyx, to the ridge and processes of the sacrum; the ligament of the joint, the great trochanter; and the linea aspera, all the way down to the knee, where its last adhesion is very strong, and from whence it comes off again, much strengthened. It is thicker on the outer side and back part, and very thin on the inner side of the thigh; it splits to embrace the sartorius, and it dives with perpendicular divisions among the muscles of the thigh, and is even connected with the sheath of the great vessels.

The USE of this tendinous membrane has been quite overlooked. While it gives attachment to muscles, and embraces them like the other fasciæ, it performs a much more important office. Its connections enable us to throw the weight of the body on one limb, and, as it were, to hang the weight of the body on the pelvis, independent of muscular exer-

tion. When a soldier, from a constrained and stiff position in the ranks, is standing equally on both legs, his joints are kept straight by muscular exertion; but when at the words, stand at ease, he throws himself on one leg, and relaxes the other, the body, supported by the spine, and the spine by the pelvis, weighs behind the centre of the acetabulum; then the fore part of the ilium rises; the fascia is stretched; the muscles of the thigh become braced; the patella is drawn up; the knee grasped by the membranes, and the leg extended. The whole limb is thus embraced and extended by the *weight* of the body thus operating on the fascia, to the relief of muscular exertion.

This is a very beautiful mechanical provision for saving muscular power; and while the body rests alternately on one leg or the other, it throws the whole body into a position of ease and grace. But when there is weakness, as in young people, or when there comes to be a habit of standing on one foot, the necessary obliquity of the pelvis produces an obliquity of the spine, and at last permanent distortion of the spine.*

In a surgical point of view the fascia of the thigh is a subject of the utmost consequence, as it regards hernia, aneurism, and abscess.

Fascialis. *Or.* sup. ant. spine of the ilium.

CLVIII. The FASCIALIS MUSCLE. — This muscle is named also tensor vaginæ femoris. It arises from the upper spinous process of the ilium, *i.e.* from the fore part, or very point of its spine, by a tendon of about an inch in length. It is very small at its origin, and at its termination. It is thick and fleshy in the middle, swelling out; it extends downwards, and obliquely backwards, almost to the middle of the thigh, and there it terminates obliquely, betwixt the two lamellæ of the membrane to which it belongs.

In. fascia lata.

Its use is chiefly as an abductor, and to make the fascia tense, to prepare the muscles for strong

* The consequences of this obliquity of the pelvis in young people is very fully treated of in Mr. Shaw's folio work on the Distortions of the Spine.

action; and, perhaps, by its adhesions about the trochanter, it may have some little effect in rolling the thigh, so as to turn the toes inwards, and oppose the Gemini.

CLIX. Psoas magnus. — This and the following muscle come from within the body to move the thigh forwards. This is a very long and fleshy muscle, of considerable strength, of constant use, perpetually employed in moving the thigh forward, or in supporting the pelvis upon the thigh-bone, so as to preserve the equilibrium of the body. *Psoas magnus.*

The psoas is a large round muscle, very strong, of great length, filling up all the space upon either side of the spine, and bounding the pelvis at its side. It comes from under the ligamentum arcuatum of the diaphragm; for it arises first by its uppermost head from the last vertebra of the back, then successively from each of the vertebræ of the loins. It sticks close to the lumbar vertebræ; for it arises not only from the transverse processes, but from the sides of the bodies. These heads do not appear, for they are covered by the body of the muscle, which goes down thick and round, till it reaches the sacro iliac symphysis, and then being united to the internal iliac muscle, they descend through Poupart's ligament. It is inserted into the lesser trochanter of the thigh-bone, and into the body of the bone, a little below the root of the process. *Or. 1, body of last dorsal vert. 2, bodies and trans. process. of all the lumbar vert.* *In. trochanter minor.*

CLX. The psoas parvus does not, like this, belong to the thigh, but is a muscle of the loins, which arises along with this one from the last vertebra of the back and the first of the loins. *Psoas parvus.* *Or. last dors. vert. and 1 or 2 of loins.*

It is a small and delicate muscle, ends in a slender tendon, which goes down by the inner side of the great psoas, but does not go out of the pelvis along with it: it stops short, and is implanted into the brim of the pelvis, into the os ilium near the place of the acetabulum: it bends the spine upon the pelvis. This muscle is more regular in the monkey: in the dog it is seldom wanting. It is said to be more frequently found in women than in men; in *In. brim of the pelvis.*

both, it often is not to be found: but sometimes, in strong and big men, three psoas muscles have been found. This muscle is so small, and so powerless, in regard to the motion of the trunk, that looking to the connection of its tendon with the Poupart ligament, I regard it rather as closing the opening to the thigh, and strengthening the abdominal tendons in their insertion into the os pubis.

Iliacus internus.

CLXI. The ILIACUS INTERNUS is a thick, very fleshy, and fan-like muscle, which occupies the whole concavity of the os ilium.

Or. 1. internal lip of the crista ilii, 2. the hollow and fore part of the same, 3. transv. pro. of the last lumb. vert. *In.* trochanter minor.

Its origin is from the internal lip of the crista ilii and transverse process of the last lumbar vertebræ: it adheres to all the concave surface of that bone, down to the brim of the pelvis; to the fore part of the bone under the spinous process; and to a part also of the capsular ligament of the joint: all its radiated fibres are gathered together into a tendon at the ligament of Poupart. This tendon is longer on the lower than on the upper surface: for below, it slides on the pubes as upon a pulley, and continues tendinous that it may bear the friction; but above it is unconnected, or it is connected only by loose cellular substance; and there it is quite fleshy. Just under the ligament the two tendons are joined, whence they bend obliquely round, to be implanted into the lesser trochanter.

The psoas magnus and iliacus internus are two very powerful muscles. *Their chief use is to bend the thigh, whilst the psoas, as arising from the vertebræ, is more particularly for supporting the body.*

We must not pass from the study of these muscles, without paying attention to the ILIAC FASCIA, which is very important in a surgical point of view.

Although the term origin of the fascia is used in description, it is incorrect; for there is no resemblance betwixt the connections of fascia with the spines of bone, and the origin of muscles from bone. From the inside lip of the spine of the ilium, a strong tendinous membrane or fascia stretches over the

iliacus internus muscle. This fascia continues upwards over the psoas magnus, and may be traced over the lateral parts of the lumbar vertebræ. Downwards and forwards it connects itself with the inner edge of the Poupart ligament, from which it may be traced into the APONEUROSIS, which lines the inside of the muscles of the abdomen.

This fascia extends betwixt the iliac and psoas muscles and the peritoneum; and by its connections to the os ilii and os pubis, and to the tendon of the abdominal muscles, at the part called Poupart ligament, it completes and secures the *walls* of the abdomen. But if matter should be formed by the side of the vertebræ, or in the cellular membrane, which is around the psoas muscle, it has an easy descent behind this fascia, and under the Poupart ligament, into the thigh, by a canal posterior to that which admits the descent of hernia.

We return to the muscles of the thigh.

CLXII. The PECTINEUS OF PECTINALIS, so named from its arising at the pecten or os pubis, is a broad, flat, square muscle: it lies alongside of the last described muscles, and is inserted with their common tendon. It arises flat and fleshy from that part of the os pubis which is bounded on the upper part by the linea ileo pectinea, and on the lower by a ridge running from the tuberous angle of the pubes to the upper part of the acetabulum, and is implanted into the linea aspera, immediately below the trochanter minor, by a tendon flat and long, pretty nearly of the same extent and shape with its origin.

Pectineus.

Or. upper and fore part of the os pubis, above the foramen. *In.* linea aspera below the trochanter minor.

This muscle lies immediately under the skin and fascia lata: and by its bending round under the thigh-bone, it has three actions; to close the knees together; to pull the thigh forward; to perform rotation, turning out the toe; and, in certain positions of the limb, it will pull the thigh back, assisting the extensor muscles.

CLXIII. The TRICEPS FEMORIS is a broad flat muscle, with three heads, arising from the os pubis, also in part from the ischium, and inserted into the whole

length of the linea aspera down to the condyle, and serving for pressing the knees together; when the thigh is behind, they must assist in bringing it forward; when the thigh is forward, they must carry the body perpendicularly over the thigh-bone, so that, besides being adductors, these muscles are in incessant operation in walking.

The triceps consists of three heads, which lie in different layers, one above the other; and have so little connection among themselves, that they have been more commonly, and I think properly, described as three muscles. These three parts of the muscle are, indeed, for one common use: but they are of very different forms; for they do not even lie on the same plane: one is long, another shorter by one half, a third larger than both the other two; so that they have been commonly described under the names of ADDUCTOR PRIMUS OR LONGUS; ADDUCTOR SECUNDUS OR BREVIS; ADDUCTOR TERTIUS OR MAGNUS.

Adductor longus.

Or. upper and fore part of the os pubis and ligament.

In. middle and back part of the linea aspera.

1. The ADDUCTOR LONGUS is the uppermost layer; its border (for it, like the pectinalis, is a flat muscle,) ranges with the border of the pectinalis. It arises from the upper and fore part of the os pubis and the ligament of the symphysis by a short roundish tendon, very strong: it swells into a thick fleshy belly, not round, but flattened; the belly grows flatter as it goes down towards the thigh-bone; it ends in a flat and short tendon, which is inserted into the linea aspera in all its middle part, viz. about four inches. Thus, the muscle is of a triangular form, with its base in the linea aspera, and its apex on the os pubis. Its head or origin lies betwixt the pectinalis and the gracilis: its upper edge ranges with the pectinalis; its lower edge lies upon the triceps magnus. It is called longus, because it is longer than the next muscle.

Adductor brevis.

2. The ADDUCTOR BREVIS lies under the adductor longus, and is of another layer of muscles; for as the first layer consists of the pectinalis, adductor longus, and gracilis, this layer consists of the obturator externus, adductor brevis, and adductor mag-

nus. The adductor brevis is exceedingly like the former, in rising near the symphysis pubis, by a thick and flattened tendon, swelling like it into a strong fleshy belly; like it, it grows flat, and is inserted by a short flat tendon into the inner trochanter and upper part of the linea aspera. But it differs in these points: that it is less oblique, for this muscle being shorter goes more directly across betwixt the pelvis and the thigh; that it is placed higher than the last, so that whereas the layers are inserted into the middle of the thigh-bone, this one is inserted into the lesser trochanter, and only the upper part of the linea aspera; and the triceps longus is a superficial muscle, while this is hidden under it, and behind it. The longus takes its rise from the very crest of the os pubis; this takes its origin from the fore part of the os pubis, from the ramus just under the crest, so as to be immediately under the head of the longus.

Or. os pubis below the last.

In linea aspera, from the root of the lesser trochanter to the commencement of the insertion of the next.

3. The ADDUCTOR MAGNUS, the third head of the triceps, is a very long and flat muscle, lying behind the other heads. It arises by a short tendon, just under the tendon of the adductor brevis; it continues to have a fleshy origin all down the ramus of the pubes and the ramus ischii to the tuber, *i. e.* from the flat edge of the thyroid hole. From this broad origin, it goes to be implanted into the thigh-bone the whole length of the linea aspera, its fibres having various degrees of obliquity, according to their insertion, for the uppermost fasciculi go almost directly across, to be inserted flat into the upper part of the linea aspera; the succeeding fasciculi go more and more obliquely as they descend, the lower part of the muscle following that rough line which leads to the condyle, and the last fibres of all are implanted, by a tendon of considerable length, into the condyle itself. This adductor magnus makes as it were a flat partition betwixt the fore and the back parts of the thigh; and it is about three inches above the condyle that the great artery passes betwixt this tendon and the bone perforating the triceps, to get

Adductor magnus.

Or. the ramus pubis, and ramus ischii.

In. linea aspera, and inner condyle of the femur.

from the fore to the back part of the thigh, and down into the ham.

The use of all these muscles is entirely the same; making allowance for their various degrees of oblique insertion; and they must be very powerful, by the great distance of their origins from the centre of that bone which they move, so that while other muscles pull in a direction very oblique, these three heads of the triceps must pull more at right angles, and, therefore, at a more favourable direction.

Obturator externus.

CLXIV. The OBTURATOR EXTERNUS is named after the obturator ligament, from which it arises. The ligament and the muscles shutting up the foramen thyroideum are named OBTURATORS, and this is sometimes named ROTATOR FEMORIS EXTRORSUM, from its turning the thigh outwards. It arises from the ramus of the ischium and os pubis, where they form the margins of the thyroid hole; and from the outer surface of the ligament, which it occupies entirely, leaving only room for the obturator vessels and nerves. It is a short muscle: its origin is broad, and its insertion narrow, so that it is of a conical form; for the flesh of its muscles is gathered very soon into a round short tendon, which twists under the thigh-bone betwixt it and the pelvis; so that it is in a manner rolled round the thigh-bone, being inserted into the root of the great trochanter. It pulls the thigh forwards, but is more peculiarly a rotator of the thigh. This muscle is of the second layer, and the succession of all the muscles is this; the upper layer consists of the psoas and iliacus, where they come out from the abdomen, of the pectinalis, and of the long head of the triceps; the second layer consists of the short head of the triceps; and the third layer consists of the obturator externus at the upper part, and the triceps magnus, or third head of the triceps, all down to the condyle.

Or. crus pubis, and ischii, membrana obturatoria.

In. cavity under the trochanter major.

GLUTÆI.—There are three glutæi muscles, each under the other, and each smaller than the muscle which covers it. The FIRST, arising from the back part of the ilium, the back of the sacrum, and the

sacro-sciatic ligament, forms the whole hip, and descends so low as to be inserted into one third of the length of the linea aspera, and into the root of the great trochanter.

The SECOND arises from all that portion of the ilium which is before this one, and from the back of the bone, and goes down to be inserted into the very top of the great trochanter.

The THIRD arises from the back of the bone below the last; and it is inserted into the root betwixt the apex of the great trochanter and the neck of the bone.

CLXV. The GLUTÆUS MAXIMUS arises from the back of the ilium nearly one half its length; from the joining of the ilium and sacrum; from all the spines and irregularities of the sacrum; and from the sacro-sciatic ligament and os coccygis. Its thick fleshy fasciculæ come in a winding and oblique direction down to the thigh-bone; and, being gathered into a flat and pretty broad tendon, it is inserted into the root of the trochanter major, and down three inches of the outside of the linea aspera. This is one of the largest and most fleshy muscles of the body; covers all the other muscles of the hip; forms the contour of the hip; pulls the thigh backwards, or the body forwards upon the thigh, when the thigh is fixed: and being a wide-spreading muscle, which, in a manner, surrounds its joint, its different portions act with different effects; not only according to their natural direction, but according to the accidental position of the pelvis with regard to the thigh-bone. A large bursa lies under the broad tendon of this muscle.

Glutæus maximus. *Or.* 1. back part of the spine of the ilium; 2. os sacrum; 3. sacro-sciatic ligament; 4. os coccygis. *In.* linea aspera, at the upper part.

CLXVI. The GLUTÆUS MEDIUS or MINOR is smaller than the former, but like it. It arises from all the outside of the ilium not occupied by the glutæus major. It, like the other, is a fan-formed muscle; for its fibres converge from its broad origin in all the back of the ilium, to form a short flat tendon which is inserted into the back, or into the very top of the great trochanter. It lies in part under the glutæus maximus; but its chief part lies before the

Glutæus medius. *Or.* anterior sup-spinous process, spine and dorsum of os ilii. *In.* trochanter major.

glutæus maximus; and as certain portions of the muscle are before the thigh-bone, there are positions of the pelvis and thigh-bone in which it will pull the thigh forwards, although its proper office is to assist the glutæus magnus in pulling the thigh backwards, and moving it outwards from the body.

Glutæus minimus. CLXVII. The GLUTÆUS MINIMUS is a small radiated muscle, which lies deep, and quite under the former. It has, compared with the former, a very narrow origin; for it arises chiefly from the lowest part of the back of the ilium, viz. that part which forms the socket for the thigh-bone, and a little higher up, and from the border of the sciatic notch. Its origin from the dorsum ilii is bounded by a ridge, which extends from the upper part of the acetabulum to the notch. It forms a short, flat, and strong tendon, which is fixed to the fore part of the trochanter major, betwixt the trochanter and the neck of the bone; so that these muscles are inserted in this succession; first, the great glutæus, below the root of the trochanter, and into the linea aspera; the middle glutæus into the back and top of the trochanter; and the smallest of the glutæi is implanted into the roughness on the fore and upper part of the trochanter.

Or. 1. dorsum ilii, 2. the ridge, and 3. the edge of the great notch.

In. fore part of trochanter major.

Gemellus sup. GEMINI. — The gemini are two muscles, or rather one biceps muscle; but the heads are so distinct, that they are reckoned two, and so much alike, that they are named GEMINI.

Or. spinous process of the ischium.

CLXVIII. The uppermost, the larger, and stronger muscle, arises from the spinous process of the os ischium.

In. root of the trochanter.

Gemellus inferior. CLXIX. The second or smaller head arises in like manner from the tuber ischii, upon its ball or outer end. They are fleshy in their whole length. They meet, and unite their tendons at the great trochanter. They are inserted firmly along with the tendon of the obturator internus, at the root of that process.

Or. tuber ischii.

In. root of the trochanter.

Pyriformis. CLXX. The PYRIFORMIS, or pyramidalis, comes from the hollow of the sacrum, runs in the same line with the lesser glutæus, and is inserted with the

two last named muscles in the root of the great trochanter.

Its origin is from the hollow of the sacrum, rising from the vertebræ of that bone, by three or four small fleshy digits, and from the sacro-sciatic notch; it runs over the sacro-sciatic ligament betwixt the glutæus minor and the gemellus superior, and its round tendon is inserted betwixt them, somewhat connected with each.*

Or. from 3 bones of the sacrum, from the os ilii.
In. cavity under the great trochanter.

The pyriformis, gemini, obturator internus, and quadratus, form what some anatomists have called MUSCULI QUADRIGEMINI: and they are so much alike in insertion and use, that it would be waste of time to repeat what has been said of the gemini and obturator.

This muscle, the pyriformis, like the others, rolls the thigh outwards. Its name is from its shape.

CLXXI. The OBTURATOR INTERNUS, once named MARSUPIALIS OR BURSALIS, arises from all the internal surface of the obturator ligament, and from all the edges of the thyroid hole, from the ilium, ischium, and pubis. Its origin is therefore circular and fleshy. It runs along the inside of the os ischium, turns round that bone betwixt the spinous process and the tuber. The hollow there is guarded with cartilage, and this tendon runs in the hollow, like a rope round a pulley; passing this, it runs betwixt the two legs of the gemini, and its tendon is united to theirs; and the three appearing almost like one tendon, are inserted together into the root of the trochanter major. These, then, might with some propriety be named *one* muscle; all the three, viz. the two gemini muscles, and the obturator muscle passing between them, were once accounted as one muscle, and then it seemed to be a muscle with two bellies, and an intermediate tendon: and this intermediate tendon, with two fleshy ends, gives it the appearance of a purse, thence named MARSUPIALIS OR BURSALIS.

Obturator intern.
Or. all the edge of the thyroid hole and obturator lig.
In. root the trochanter.

* This muscle is frequently divided by the great sacro-sciatic nerve.

Quadratus femoris.

CLXXII. The QUADRATUS FEMORIS is a thin flat muscle, passing in a transverse direction betwixt the tuber ischii and the thigh-bone.

Or. tuberosity of the ischium.

It arises from the lower and flattened surface of the TUBER ISCHII by a short tendinous beginning. It goes a little obliquely upwards and outwards, and is inserted into the back of the great trochanter, in that roughness which is found just where the trochanter is joined to the bone, and goes obliquely betwixt the trochanter major and the trochanter minor.

In intertrochanteral line.

It rolls the thigh-bone, so as to turn the toe outwards, and pulls it almost directly backwards.

The MOTIONS of the THIGH must be performed by many very strong muscles, as it moves under the weight of the whole body; and it seems to be curiously contrived, that the muscles fit for moving the thigh forward should in certain positions of the thigh move it backwards; also giving an increase of strength to that motion of the thigh in which most strength is required.

There are but two, or chiefly two points for insertion; the trochanter major and trochanter minor. These two points are so oblique, that no one muscle, nor set of muscles, performs any direct motions; for they all twist round the bone's axis, to get at their insertion. The glutæi, the pyriformis, the gemini, the quadratus, the obturator internus, and obturator externus, all bend round the axis of the thigh-bone, to reach the TROCHANTER MAJOR. These now may be called the abductors of the thigh, to pull it outwards; but we should conclude from this direction, that they could not pull the thigh backwards, for the thigh-bone would turn on its axis and elude their action.

The psoas magnus, the iliacus internus, the pectinalis, and the triceps, do in the same manner go round the inner side of the bone: the two first to be implanted into the trochanter minor, the two latter into the linea aspera, just below it. These are justly named adductors of the thigh; their chief use

is to draw the thighs together, and this is their combined effect: when the adductors act by themselves, they pull the thigh forwards, moving the leg, rolling the thigh-bone, and turning the toe out in a graceful step; which is most peculiarly the effect of the pectinalis and triceps. But when we are to finish the motion, by pulling forward the body, which is the same with pulling back the thigh, it is not merely the antagonists of these muscles, as the glutæi, the gemini, &c. which must act. Were the glutæi to act alone, they would rather turn the thigh upon its axis outwards than pull it back; but the triceps, &c. act again in conjunction with the glutæi, &c. and by the action of the triceps the inner trochanter is fixed; the further rolling of the thigh is prevented; the full effect is given to the glutæi muscles. When the glutæi act, they pull the thigh directly backwards, assisted by the triceps, pectinalis, and others: for now the thigh-bone is so far advanced before the body, that those muscles, as the triceps which were benders of the thigh in its first position, are extensors when it is advanced a step before the body; or perhaps, it will be more explicit to say, that when the thigh is moved one step before the body, the iliacus internus, psoas magnus, and triceps muscles, agree with the glutæi muscles in bringing the trunk forwards to follow the limb, and then in fixing and stiffening the trunk upon that limb, till the other thigh is advanced again a step before the body.

The consideration of the uses and actions of the muscles are very necessary to the surgeon. If we suspect that the lameness we perceive in a patient is arising from the hip-joint, we make him throw out the thigh in abduction, because the glutæi are abductors, and they press the hip-joint in that operation, and give pain, and thus prove the seat of the complaint. In the same manner, when there is disease in the course of the psoas magnus, the patient stoops, and he cannot extend his thigh, because that stretches the psoas muscle.

The MUSCLES moving the LEG are the most simple of all; for the knee is a mere hinge, at least it is so in all our ordinary motions, so that there is no action to be performed, but those of mere flexion and extension, and there are only two classes of muscles to be described, the extensors and the flexors of the leg.

1. The EXTENSORS of the LEG. — The only muscles which extend the leg are those four, which may be very fairly reckoned a quadriceps extensor cruris. Indeed the French anatomists arrange them so. Sabatier calls them the triceps femoris. These muscles, which all converge to the patella, and are inserted in it, are RECTUS FEMORIS, — CRURÆUS OF FEMORÆUS, — VASTUS EXTERNUS, — VASTUS INTERNUS.

And these are all implanted by one tendon; because the joint being a hinge, bending only in one direction, its muscles could have given but one motion, however oblique their origin and course had been.

2. The FLEXORS of the LEG are two on the outside and four on the inside of the thigh; the tendons of the outside being implanted into the upper knob of the fibula, and those in the inside into the rough head of the tibia, forming the ham-strings, and extending their tendons or aponeurotic expansions downwards upon the leg.

INSIDE FLEXORS.

Sartorius,	Gracilis,
Semitendinosus,	Semimembranosus.

OUTSIDE FLEXORS.

Biceps.	Poplitæus.

EXTENSORS OF THE LEG.

Rectus femoris. CLXXIII. The RECTUS FEMORIS, sometimes RECTUS CRURIS, is so named from its direction; it arises by two heads. The first or greater head arises from

the lower spinous process of the ilium by a short round tendon; its second head is in a different and somewhat of a curved direction: for it comes from the edge of the acetabulum, and from the capsular ligament. These join together, and form a flat tendon of four inches in length, which becomes gradually fleshy and larger down to its middle, and then again contracts towards the patella. There is a middle tendinous line, running the whole length of the muscle, especially conspicuous on its back part, and towards that central line all the muscular fibres converge.

Or. infer. ant. spin. pro. of the ilium, and upper edge of the acetabulum.

The rectus is united at the sides to the vasti, at the back part to the cruræus; and its tendon, along with that of the cruræus, goes to be directly implanted into the rotula or patella.

In. upper part of the patella.

The rectus cruris is the first of those muscles which Sabatier calls the TRICEPS FEMORIS; they may be more properly named the QUADRICEPS CRURIS.

This large mass of muscle or flesh enwraps the whole of the thigh-bone behind as well as before; for, first, the CRURÆUS arises fleshy from all the fore part of the bone; the VASTUS EXTERNUS from the great trochanter, and all the back part and outer side of the bone; and the VASTUS INTERNUS arises, in like manner, from the lesser trochanter, and all the inner side of the bone, from the trochanter major all round to the origin of the cruræus.

CLXXIV. The CRURÆUS arises from the fore part of the femur, between the two trochanters, and it continues its origin from the fore part of the femur, the whole way down to within two inches, or little more, of the patella. About three inches from its origin it is joined by the VASTUS EXTERNUS, which unites with it at the outer edge and fore part; and the VASTUS INTERNUS comes into it about five inches below its origin, and it joins it at the inner edge and fore part. At its lower part it is joined to the tendon of the rectus, to form but one large tendon, which is inserted into the rotula. By Albinus, the plate of

Cruræus. Or. fore part of the femur.

In. the patella under the rectus.

this muscle is given in union with the two vasti, which is the best method of describing the muscle, as it is very seldom to be made out distinct from these two muscles.

Under the cruræus are sometimes found two little muscles, or rather two little slips of this muscle, which are quite distinct. They arise on the fore part of the thigh-bone, two or three inches above the capsule of the joint; and they are inserted into the capsule on each side of the patella, evidently for the purpose of pulling it up to prevent its being caught; and when these two (SUBCRURÆI) are not found as distinct muscles, some fibres of the cruræus supply their place.

Vastus externus.

CLXXV. The VASTUS EXTERNUS is the largest of these three muscles.

Or. root of the troch. major, and the linea aspera.

Its origin is, by a pretty thick and strong tendon, from the lower and fore part of the trochanter major; and it continues its origin from the root of the trochanter all down the linea aspera, to that rough line which goes to the outer tuberosity of the thigh-bone.

In. the patella laterally, and the fascia of the knee-joint.

It touches the end of the cruræus about four inches below its origin, and continues attached to it the whole way down; and then it forms a flat tendon which connects itself with the tendon of the RECTUS FEMORIS, and then embraces, in a semi-circular manner, the outside of the patella. And several of the fibres of this aponeurosis not only cross over the rotula, but go down over its opposite side to glide along the head of the tibia, and to be inserted into the inner side of the knee.

Vastus internus.

CLXXVI. The VASTUS INTERNUS is neither so large nor so fleshy as the VASTUS EXTERNUS; but it is exceedingly like it in all other respects.

Or. 1. root of troch. minor. 2. linea aspera. 3. fore part of the bone.

It arises from the fore part of the trochanter minor, just under the insertion of the psoas magnus, and from the fore part of the thigh-bone; it continues its origin from the linea aspera the whole way down to the inner condyle, exactly opposite to the origin of the vastus externus; they leave merely a channel

betwixt them. The vastus internus, very soon after its origin, joins itself to the cruræus, or middle portion, and accompanies it in all its length; and, at the distance of two inches from the rotula, it unites itself with the tendon of the cruræus at its internal edge; and this tendon completes that junction which unites the four muscles into a quadriceps cruris. This vastus internus descends much lower, in a fleshy form, than the external vastus does, and forms that fleshy cushion which covers the inner side of the knee-joint. Its tendon embraces the rotula, somewhat in the same circular form with the vastus externus; and, like the externus, it sends some fibres across the knee-pan, to be inserted in the outer part of the head of the tibia.

In. inside of the patella, and into the fascia.

The RECTUS, and the VASTUS EXTERNUS, INTERNUS, and CRURÆUS, form one large mass of flesh, which embraces and encloses all the thigh-bone; and they are so connected, that the cruræus cannot be separated, and cannot be neatly distinguished.

The use of these four muscles is evident; to extend the leg, and to bend the thigh on the trunk, or reciprocally to bend the trunk on the thigh. This, or these two motions alternately, is the common use of these muscles, as in walking; and they are most peculiarly useful in running and leaping.

After describing a large mass, conjoined in one tendon, and concurring in one simple action, it is superfluous to say that its power must be great. This power must be still farther increased by the rotula, which removes the force from the centre, and gives the advantage of a pulley, which it really and truly is: without this pulley, these muscles could be of no use in certain situations; for instance, in the recumbent posture: for then the extending muscles, being in the same line with their bones, could have no further power; but the rectus, by the pulley of the rotula, and by its attachment to the pelvis, raises the trunk, or at least helps the psoas, the iliacus, and the muscles of the belly.

The rotula is again attached to the tibia by a strong ligament, to sustain the pulling of these great muscles.*

The surgeon would do well to remember the attachment of the rectus to the pelvis in the case of fractured patella, and to see the necessity of raising the body of the patient, to keep the broken parts of the bone in contact.†

FLEXORS OF THE LEG.

Sartorius.

CLXXVII. The SARTORIUS OF TAILOR'S MUSCLE, is so named from its bending the knees, and drawing the legs across. It is the longest muscle, and a very beautiful one; extends obliquely across the whole length of the thigh, crossing it like a fillet or garter, about two inches in breadth.

Or. supant. spin. process of the ilium.
In. inner tubercle of the head of the tibia.

It arises from the upper spinous process of the os ilium, by a tendon about half an inch in length; its thin flat belly extends obliquely across the thigh, like a strap, and is inserted in the same oblique form into the inner tubercle of the head of the tibia; its aponeurosis spreads widely, going over the whole joint of the knee, a thin sheet of tendon.

From the oblique position of the muscle, it might in action change its place; but it is so far embraced by the fascia lata, and is tied by such adhesions, as to form something like a peculiar sheath of itself.

* These muscles are in continual action; for their office is to resist the bending of the knee, which would happen by this incumbent weight of the body; so that the continual support of the body depends wholly on these muscles; and they are the great agents in running, leaping, walking, &c. Since by extending the knee they raise the weight of the pelvis and trunk, and of all the body, they must be very powerful; and accordingly, when they are weighed against their antagonist muscles, we find them greatly to exceed, for the QUADRICEPS, *i. e.* the rectus cruræus, and vasti, weigh four pounds, while the BICEPS, &c. their antagonists, weigh but two pounds. This experiment was often repeated by the great Cowper, for Mr. Brown, who was delivering lectures on muscular motion.

† The action of the muscles and the position of the limb in fractures of the Femur, are considered in my Observations on Injuries of the Spine and Thigh-bone.—C. B.

It turns the thigh like the quadratus, gemini and obturator muscles. It also bends the leg upon the knee; and when the leg does not yield, it bends the thigh upon the pubes; or where the thigh is also fixed, it bends the body forwards; but in performing that action, whence it has its name, it does all these; for first the leg and thigh are rolled, then the thigh is raised, then the leg is bent to draw it across. Though a small muscle, yet it is of great power from its origin, and, in some degree, its insertion also, being much removed from the centre of motion.

CLXXVIII. The GRACILIS, sometimes called RECTUS INTERNUS FEMORIS*, is a small, flat, thin muscle, in its general shape somewhat like the sartorius. Gracilis.

It arises by a flat tendon of two inches in length from the ramus of the os pubis, and near the symphysis; and it passes immediately under the integuments down to the knee; it passes by the inner condyle of the knee, in the form of a short round tendon, and, as it bends behind the head of the tibia, it is bound down by a bundle of tendinous fibres, which, crossing it, go to the back part of the leg. After passing the head of the tibia, it turns obliquely forwards and downwards; it here runs behind the tendon of the sartorius, and before that of the semitendinosus. It is inserted with the sartorius into the side of the tuberosity, at the top of the tibia. Or. ramus pubis. In. below the sartorius.

This muscle runs also in a line so wide from the centre of motion, that its power is very great. It serves chiefly as a flexor of the leg: when the leg is fixed, it must by its origin from the pubes be a flexor of the thigh, and an adductor in nearly the same direction with the pectineus and triceps; and it is worth observing, that while the knee is straight, the sartorius and the gracilis cannot bend the knee; they, on the contrary, keep it steady and firm; but when

* GRACILIS, is from its smallness; RECTUS INTERNUS, is from its straight direction.

the knee is bent, they come into action; for, in proportion as the muscles which have made the flexion are contracted, they are less able to contract farther, and therefore it is desirable that more muscles should come into play.

Semitendinosus. CLXXIX. The SEMITENDINOSUS is so named from its lower half being composed of a small round tendon; and as tendon was once misnamed nerve, this is the SEMINERVOSUS of Winslow, Douglas, and others.

Or. tuber ischii. Its origin is from the tuberosity of the ischium, (along with the semimembranosus, and touching the biceps,) by a short thick tendon. It also arises, by many oblique fasciculi of fibres, from the posterior portion of its opposite muscle the biceps cruris. This cross connection betwixt the two muscles continues for three inches down from the tuber ischii; it then departs from the biceps, goes obliquely inwards, and is flattened and contracted into a tendon, six inches from the knee, and getting round the head of the tibia, it comes forward to be inserted into the tuber, at the head of that bone. At this place, the tendon grows broad and flat; it is expanded, and as it were grasps the inner side of the knee; its upper edge is joined to the lower edge of the tendon of the gracilis, so that the sartorius, gracilis, and semitendinosus are implanted like one muscle; and this tendinous expansion seems like a capsule, for enclosing the heads of the tibia and femur, and for strengthening the knee-joint. The semitendinosus bends the leg.

In. into the tibia below the gracilis.

Semimembranosus. CLXXX. The SEMIMEMBRANOSUS has its name from the muscle, which is flat, thick, and fleshy, beginning and ending with a flattened tendon, somewhat like a membrane, but infinitely thicker and massier than such name should imply.

Or. tuber ischii. It arises from the tuber ischii, before the semitendinosus and biceps. It arises a broad, thin, and flat tendon, of about three inches in length. It becomes fleshy and thick in its middle, but it soon becomes thinner again, and terminates in a short

tendon, which, gliding behind the head of the tibia, is inserted there.* *In. head of the tibia.*

This muscle has little connection with any other. It lies under, or, more particularly speaking, on the inside of the semitendinosus, and the two together form the inner hamstrings. The hamstring muscles contribute also to another motion. Though when extended the tibia cannot roll, yet when we sit with our knees bent, it can roll slightly; and such rolling is accomplished by these muscles. All these muscles which bend the leg, and which consequently extend the thigh at the same time, are muscles of great power, because they arise in one common point; the tuber ischii and that point is very far distant from the centre of motion.

There is still one small muscle, a flexor of the leg, which performs this rotation during the bent state of the knee, with most particular power.

CLXXXI. The MUSCULUS POPLITÆUS, which is so named from its lying in the ham, is a small triangular muscle, lying across the back part of the knee-joint, very deep under the hamstrings, and under the muscles of the leg. *Poplitæus.*

Its origin is from the outer condyle of the thigh-bone, and from the back part of the capsule of the joint; its tendon is short and thick, but of no great extent. It passes fleshy behind the knee-joint; and it is inserted broad into a ridge on the back part of the tibia; so that by its small origin and broad insertion, it is a fan-like muscle, its upper fibres being almost transverse, and its lower fibres nearly perpendicular. Besides bending the leg, it is useful by pulling aside the capsule to prevent its being caught. *Or. ext. condyle.* *In. triangular surface on the back of the tibia.*

CLXXXII. The BICEPS FLEXOR CRURIS, so named from having two heads, a long and short one, lies immediately under the skin, in the back part of the leg, *Biceps cruris.*

* The two tendons of this muscle, the membranous tendon at the head, and this smaller one by which it is inserted, stand so obliquely, that the muscular fibres betwixt them must be very oblique; for the membranous tendon descends low upon the back part or edge, and the tendon of insertion begins high upon the fore edge of the muscle.

running down from the pelvis to the knee, to form the outer hamstring.

Or. tuber ischii. It is the single flexor on the outside of the thigh. Its origin is from the outer part of the tuber ischii, by a tendon of an inch and a half in length. And this tendon is, in its origin, closely united with that of the semitendinosus for two inches, or at least the whole length of the tendon. After a short, but very thick fleshy belly, it degenerates into a tendon, especially on its back part; and this tendon, which begins above the middle of the thigh, is continued the whole way down.

2. linea aspera. About one third down the bone is the beginning of the second, or short head, which has its origin all the way down the linea aspera, to the line above the outer condyle of the thigh-bone; and here it is somewhat connected with the origin of the vastus externus muscle, and the insertion of the glutæus maximus. The tendons of the two heads are joined a little above *In. head of the fibula.* the outer condyle, and go outwards to be inserted into the outer part of the head of the fibula forming the outer hamstring.

Its insertion surrounds the head of the fibula, and a small portion also sinks betwixt the bump of the fibula and the inner head of the tibia, to be implanted into it also.

This muscle, like the opposite ones, serves for bending the leg. The short head simply bends the leg. The long head assists the short one in bending the leg, and is also a muscle of the thigh.

FASCIA. We must not relieve our attention from these posterior muscles of the thigh without considering the manner in which the great fascia comes down on the back part of the thigh to cover them, and to form the POPLITEAL CAVITY. The fascia, strengthened as it were by its connection with the LINEA ASPERA, stretches down over the hamstring muscles and their tendons, embraces them, and holds them together; and betwixt the flat part of the femur, the hamstring tendons laterally, and the fascia behind, there is a cavity, (if we may call that a cavity which

is filled with loose cellular membrane and fat,) which transmits the popliteal artery and vein and nerve. This cavity is particularly important to the surgeon, because the artery here is subject to disease or rupture; and then the popliteal aneurism is formed.

The muscles of the foot are six EXTENSORS and two FLEXOR MUSCLES.

EXTENSORS.

GASTROCNEMIUS vel GEMELLUS, PLANTARIS, GASTROCNEMIUS INTERNUS, vel SOLEUS, TIBIALIS POSTICUS,	lying on the back part of the leg.
PERONÆUS LONGUS, ——— BREVIS,	on the outside of the leg.

FLEXORS.

The TIBIALIS ANTICUS, The PERONÆUS TERTIUS,	lying on the fore part of the leg.

CLXXXIII. The GASTROCNEMIUS is often divided into two muscles, named GASTROCNEMII or GEMELLI. But, far from counting thus, we should rather favour the arrangement of Douglas, who couples this with the next muscle, as forming a quadriceps, or two muscles joined with two heads each; and he calls it the EXTENSOR SURALIS. Gastrocnemius.

The GASTROCNEMIUS is the great muscle of the calf of the leg; its two heads are two very large and fleshy bellies, which arise from the tubercles of the thigh-bone. The inner head is the larger, and arises by a strong tendon from the back of the inner condyle, and a little way up the rough line; and it has also a strong adhesion to the capsular ligament of the knee. Or, the condyles of the femur. In, oscalcis.

The outer head is shorter than this: it arises in the same way, from the outer tubercle of the thigh-bone; and the two muscles meet and run down together, forming the appearance of a rapha, by the direction of their fibres; but the two bellies continue

distinct till they meet in the middle of the leg. They are distinct at their back part, but at their fore part they are connected by a tendinous aponeurosis, or strong but flat tendon; and the two bellies being, about the middle of the leg, united firmly, they form a large flat tendon, very broad at its beginning, which unites with that of the soleus a little above the ancle.

Soleus.

CLXXXIV. SOLEUS. — This name is from its resemblance to the sole fish; and it is often named GASTROCNEMIUS INTERNUS. This, like the last muscle, has two HEADS, which arise from either bone.

Or. head of the fibula, and back part of the tibia.

One head arises from the head of the fibula, and continues to adhere to one third of the upper part of the bone; another head arises from about three inches of the part of the tibia, immediately below the insertion of the poplitæus. The first of these heads is large and round; the second is smaller and flat: they unite immediately; and a large fleshy belly is formed, with still a conspicuous division betwixt the flesh of the two heads. The great tendon begins about half-way down the leg, but still is intermixed with fleshy fibres till it approaches the heel. A little below the middle of the leg, this tendon is united with the tendon of the gastrocnemius, to form the great back tendon named tendo Achillis; and sometimes, though very rarely, chorda magna.

The tendon is large; it grows smaller as it approaches the heel; when it touches the extremity of the heel-bone, it expands to take a firmer hold.

In. os calcis.

In running, walking, leaping, &c. this muscle, with the extensors of the leg, are the principal agents. The external gastrocnemius has double power; for, arising from the tubercles of the thigh-bone, it is both an extensor of the foot and a flexor of the leg; but the gastrocnemius internus is a mere extensor of the foot; and both together have such strength as often to break the tendo Achillis.

Plantaris.

CLXXXV. PLANTARIS.—This muscle is named from a mistaken notion of its going to the planta pedis, or sole of the foot, to form the plantar aponeurosis, like the palmaris of the hand; but, in fact,

it does not go to the sole, but is a mere extensor of the foot, inserted along with the tendo Achillis.

This long and slender muscle is situated under the gastrocnemius externus. It arises from the external condyle of the femur wholly fleshy; it also has an attachment to the capsular ligament of the joint; after an oblique fleshy belly, of about three inches, it forms its small flat tendon. The tendon runs betwixt the inner head of the gastrocnemius and the soleus; and when the tendo Achillis begins, the tendon of the plantaris attaches itself to the inner edge and fore part of the Achillis tendon; it accompanies it down to the heel, running in a groove which seems made to receive it; and it is implanted, with the tendo Achillis, into the inner side of the heel-bone. It is often wanting.

Or. extern. condyle.

In. inside of the os calcis.

The use of this muscle is to tuck up the capsule, in the great bendings of the knee-joint, and to assist the gastrocnemii muscles.

The PERONÆI muscles are those which arise from the fibula. They are named from their length being different; the PERONÆUS longus being as long again as the BREVIS, for it is one half longer in its origin, the one rising at the head, the other at the middle of the bone; and again, it is one half longer at its insertion, going fully round under the foot to the opposite side, while the shorter peronæus stops at the side of the foot to be inserted.

CLXXXVI. The PERONÆUS LONGUS is so named from its lying along the fibula. It arises partly tendinous, chiefly fleshy, from the upper knob of the fibula, and from the ridge of the bone down to within three inches of the ancle. It has another small slip of a head from the upper part of the tibia, above where the fibula joins; it has also adhesions to the tendinous partition, which separates this from the EXTENSOR DIGITORUM COMMUNIS and the SOLEUS.

Peronæus longus.

Or. 1. head and almost all the fibula, 2. head of the tibia.

Its tendon begins very high above the middle of the leg, and it continues to receive the fleshy fibres, almost at right angles in the penniform manner. The tendon is concealed down to about or below

the middle of the leg. Then it is seen immediately under the integuments, and we can easily distinguish it through the skin, being that acute line or string which runs down behind the outer ancle, and which gives shape to that part.

In passing the outer ancle it runs down through a cartilaginous pulley, or annular ligament, which also transmits the peronæus brevis: it leaves the peronæus brevis on the side of the foot; and passing by itself in a groove of the heel-bone, it bends obliquely across the arch of the foot, goes quite down to the opposite side, and is inserted into the metatarsal bone of the great toe, and the great cuneiform bone on which it is founded. Under the eminence of the OS CUBOIDES, it suffers great friction, so as to be thickened to a degree of ossification, and to resemble a sesamoid bone. It is also thickened in a lesser degree, as it passes the outer ancle; and in all this length, it is tied down by a strong ligamentous expansion.

In. cuneiforme internum, and the metatarsal bone of the great toe.

It is a powerful extensor of the leg; it also gives that obliquity to the foot, which is so handsome and natural, and useful in walking. This muscle particularly turns down to the ground the inner edge of the foot; so it presses to the ground the ball of the great toe, and that is the part which touches the ground, and which feels sore after long walking, or violent leaping or running: it is by that part we push, in making a step; so that this muscle is perceived to be continually active in all motions of walking, leaping, running, and more particularly in dancing.

Peronæus brevis.
Or. ridge of the fibula, more than its lower half.

CLXXXVII. The PERONÆUS BREVIS is like its fellow, except in length and insertion. Its origin is from the ridge of the fibula, beginning about one third down the bone, and continuing its adhesion the whole way to the ancle. It also has adhesions to the tendinous partition which is betwixt it and the common extensor; so that these two muscles are, by such adhesions, very difficult to dissect. It is smaller at its origin, but increases in its fleshy belly

as it descends; and it is fleshy lower down than the peronæus longus. It is, like it, a penniform muscle. The tendons of the two peronæi pass together, by the outer ancle, in the same ring; but the tendons cross each other; for the peronæus longus is in its belly more forward. The brevis lies under and behind it, quite covered by it, and yet the tendon of the brevis, by creeping under the longus, gets before it, just under the outer ancle: and from that it runs in a separate groove, superficially upon the outer edge of the foot, to be inserted into the metatarsal bone of the little toe. In both muscles the tendon is upon the outer edge, and begins almost as high as the upper head of each muscle. This tendon of the peronæus brevis, the shorter one, is small where it passes through the pulley, and expands when it reaches its insertion, that it may grasp the metatarsal bone firmly. The tendon of the longer muscle also expands a little, and somewhat in the form of a hand and fingers, taking hold of two bones by three little heads.

In. metatarsal bone of the little toe, and the os cuboides.

This muscle assists the former in extending the foot, and coincides well in its oblique action with the last; for, as the last turned down the inner edge of the foot, this turns the outer edge upwards, which is exactly the same motion.

Peronæus tertius.

CLXXXVIII. The PERONÆUS TERTIUS is a third muscle, having its origin from the fibula; but as its tendon passes before the malleolus externus, and as it is inserted into the outside of the foot, it has a contrary action to the peronæus longus and peronæus brevis. The peronæus tertius lies on the fore part of the fibula, and rises from the middle of that bone, and down to near its lower head. Its tendon does not pass into the same sheath with the peronæus longus and brevis, but goes under the annular ligament on the fore part of the ancle-joint, to be inserted into the root of the metatarsal bone, which sustains the little toe. It is so much connected with the extensor communis digitorum, that there is often great difficulty in dividing the two. The action of

Or. lower half of the fibula.

In. metatarsal bone of the little toe.

this muscle balances the connection of the tibialis anticus, and the two together bend the foot, that is, bring it to an angle with the leg.

Tibialis posticus.

CLXXXIX. The TIBIALIS POSTICUS is a penniform muscle; its tendon goes round the cartilaginous pulley of the inner ancle.

It is named TIBIALIS from its origin, and POSTICUS from its place.

Or. 1. back of the tibia, 2. and fibula, 3. fore part of the tibia, and 4. interosseous ligament.

It arises from the back part and ridge of the tibia, from the opposite part of the fibula, and from the interosseous membrane below these. Some fibres pass between the bones at the upper part, and take an origin from the fore part of the tibia; and it continues its attachment to the interosseous ligament, quite down to the ancle. It has also strong attachments to the surrounding tendinous partitions.

Its fibres are all oblique, and go to the middle tendon, which is in the heart of the muscle. About the middle of the tibia, this tendon begins to emerge from the fleshy belly; it grows gradually smaller, but still continues to receive flesh quite down to the ancle. It passes in the groove of the inner ancle, and is retained there by such a ligament as holds the peronæi. After passing the ligament, it expands in the hand-like form, to grasp the bones of the tarsus; and it is expanded much more than the peronæus, for it sends roots down among the bones both of the tarsus and metatarsus, so as to take hold first on the lower rough part of the naviculare in passing over it. Then it is implanted into the middle metatarsal bone, then into the calcaneum, into the os cuboides cuneiforme internum and medium; and where it passes over the os naviculare, it is hardened into a sort of sesamoid bone. In short, it is implanted in the sole of the foot by a tendon like a hand, which sends down its fingers among the tarsal and metatarsal bones, to take the surest hold. This muscle pulls the foot in, so as to put the toes together, and when balanced by the peronæi, it directly extends the foot.

In. almost all the bones of the tarsus. 1. os calcis, 2. cuboides, 3. cuneiforme med. internum, 4. metatarsal of the middle toe.

Tibialis anticus.

CXC. The TIBIALIS ANTICUS crosses obliquely the fore part of the leg. It arises from the fore

part and outside of the tibia, part of the fibula, and interosseous ligament. It begins just under the outer tuber, and continues its adhesion down two thirds of the bone; then the tendon begins to be formed: and this muscle, like almost all the smaller ones of the leg, adheres to the tendinous partitions, and to the fascia, with which they are covered. The tendon begins almost with the origin of the muscle, but continues covered by the flesh, and not appearing till within four inches or so of the ancle, when it begins to pass obliquely over the leg, and having completed the crossing above the ancle, it goes under the annular ligament in a peculiar ring, runs along the side of the foot, and is implanted into the os cuneiforme internum, and a small production of the tendon goes forwards to be inserted into the metatarsal bone of the great toe.

Or 1. head and fore part of the tibia, 2. interosseous lig. 3. head of the fibula.

In. cuneiforme internum and metatarsal bone of the great toe.

This muscle turns the great toe towards the leg, and when assisted by the peronæus tertius directly bends the foot.

MUSCLES OF THE TOES.

The long muscles of the toes are just four, two FLEXORS, and two EXTENSOR MUSCLES. The flexor muscles lie upon the tibialis posticus, or behind, betwixt it and the soleus. The extensor muscles again lie under the tibialis anticus, or at least their heads are under it, and their bellies only appear from under it, about the middle of the leg.

The flexor tendons follow the tendon of the tibialis posticus, over the pulley of the inner ancle into the hollow of the foot. The tendons of the extensor muscles keep with that of the tibialis anticus, and cross over the fore part, or prominence of the ancle, where the tibia is united with the astragalus. And in dissection we must follow these in an opposite order to that in which they are described, for next to the fore part of the soleus is, 1st, the FLEXOR POLLICIS; 2dly, the FLEXOR DIGITORUM; and 3dly, the TIBIALIS POSTICUS.

Flexor longus pollicis. Or. three-fourths of the fibula, inteross. lig.

CXCI. The FLEXOR LONGUS POLLICIS is small and pointed at its origin, and arises fleshy from three fourths of the fibula, to within an inch of the outer ancle and interosseous ligament. It grows thicker and larger as it descends, and adheres to the tendinous partitions of the tibialis posticus, and of the peronæi. Its tendon can be seen only about an inch above the joint of the ancle. It passes down behind the inner ancle, where it is bound in a sort of annular ligament. It there passes under the heel-bone, in the arch of the foot, betwixt the bones and the abductor pollicis; it then glides into the channel made by the two heads of the flexor pollicis brevis; it then passes betwixt the two sesamoid bones at the root of the great toe; it then goes forward in a sheath, to be inserted into the last bone of the great toe, at which implantation it is enlarged. Sometimes it sends a small tendinous insertion into the os calcis.

In. last phalanx of the great toe.

Its office is to bend the great toe; but it is also continually useful at every step in extending the foot, or in keeping the toe firm to the ground, while the gastrocnemii raise the heel; and, therefore, we should not be rash in cutting away the great toe, for in it consists not the strength of the foot only, but of the leg.

Flexor longus digitorum.

CXCII. The FLEXOR LONGUS DIGITORUM PEDIS is named in addition the PERFORANS, because, like the perforans of the hand, it runs its tendons through the split tendon of a smaller muscle, which is lodged in the sole of the foot. It is named also FLEXOR COMMUNIS, although there be less reason here, where there are no flexors for the individual toes, than in the hand, where there are separate flexors for the individual fingers.

Or. 1. back part of the tibia, 2. septum.

It arises from the back and inner part of the tibia, its whole length, that is, from the end of the popliteal muscle, and from the septum tendinosum, by which it is divided from the tibialis posticus, which lies immediately before it; and it continues this origin from the tibia down to within three inches or so of the ancle. About the middle of the muscle

we find fibres coming across to join it from the outer edge of the tibia, and between these two sets of fibres the tibialis posticus passes. Its origin is not easily separated before from the tibialis posticus, nor behind from the flexor pollicis.

The tendon is not formed till near the ancle, (within two inches of it,) and the flesh still accompanies it quite down to the joint. It crosses the tendon of the tibialis posticus behind the ancle-joint, and goes forward in the groove of the os calcis, tied down by a sort of capsule, or annular ligament. In the arch of the foot, it crosses the tendon of the flexor pollicis, from which it receives a slip of tendon; and thus the office of either is assisted by the other, and could be wholly supplied by it: it then passes over to the middle of the sole, and growing flatter and thicker, divides into four flat tendons. These go forward, diverging till they arrive at the ends of their metatarsal bones; then they emerge from the aponeurosis plantaris, along with the common short flexor. Now both these tendons run under a ligamentous sheath, and are included in it under the first and second bones of the toes; and having perforated the short flexor opposite to the second joint, they are finally inserted into the root of the third or last bone of each toe. These tendons, like the corresponding ones of the hand, seem to be slit with a sort of longitudinal fissure.

In. the base of the third phalanx of four toes.

The proper use of this muscle is to bend the four lesser toes, to bend all their joints, but more peculiarly the last bone; and also to extend the foot, keeping the point of the toes to the ground, consequently assisting the gastrocnemii, and all the muscles used in walking, &c.

CXCIII. The MASSA CARNEA JACOBI SYLVII, or PLANTÆ PEDIS, flexor accessorius, lies in the sole of the foot; it is a small body of flesh, naturally connected with the flexor longus. The massa carnea arises from the lower part of the heel-bone, in two divisions, one (the external *one*) tendinous, the

Flexor accessorius.

Or. sinuosity of the os calcis.

other fleshy. It is, upon the whole, pretty nearly of a square form; it joins the tendon of the flexor longus, before its division into tendons for each toe, and by the advantage with which it acts in consequence of its origin from the heel-bone, it must be of great assistance to the flexor. It is more generally considered in the light of a supplementary muscle; by some, it is considered as a distinct muscle, and by others, as the origin and first beginning of the lumbricales pedis.

In. tendon of the flexor longus.

Thus Cowper considers the massa carnea, and the lumbricales, as one and the same: that the massa carnea joins the tendon, covers it with its flesh, continues fleshy along the common tendon, till at the bifurcation it also parts, along with the four tendons, into four small fleshy muscles, which are called lumbricales.

Albinus, again, paints the massa carnea, distinctly, terminating at the common tendon, and the lumbricales as arising distinct from each of the divided tendons.

Flexor brevis digitorum.
Or. lower part of the os calcis, and the plantar aponeurosis.

CXCIV. The FLEXOR BREVIS DIGITORUM is also named the flexor sublimis or perforatus. It arises from the lower part of the heel-bone, or the bump upon which we stand. It arises by very short tendinous fibres, and, being placed immediately under the plantar aponeurosis, it takes hold of it, and also of the tendinous partitions betwixt it and the two abductors of the small and of the great toe, which are on either side of it. Under the metatarsal bones, it divides itself into four heads; their tendons begin earlier upon the side next the foot; they grow round, emerge from betwixt the dentations of the plantar aponeurosis; they then pass into the vagina, or sheath of each toe; and on this, the first phalanx, they lie over the tendons of the long extensors. About the root of the first bone, they divide into two little bands, which form a split (like the perforatus of the fingers) for the passage of the long tendon.

The long tendon passes through it upon the second joint of the toe, and immediately after, the

perforated tendon fixes itself by the two forks to each side of the second bone, or phalanx of the toe. *In. the second bones of four toes.*

Its use is to bend the first and second joints of the toes, but most peculiarly the second. The obliquity of the long flexor is exactly balanced by a corresponding obliquity of the short flexor; for the tendon of the long flexor coming round the inner circle, runs obliquely outwards to reach the toes, while the short flexor, coming from the heel, which is towards the outer edge of the foot, runs in a like degree obliquely inwards, and meets the other at an acute angle near the toes.

CXCV. The LUMBRICALES must be dissected after the short flexor. They need no description, since they exactly correspond with those of the hand. They rise, like them, in the forks of the flexor tendons. They, like them, pass through the digitations of the aponeurosis. They pass on to the first bone of the toes, and, like the lumbricales of the hand, creep over the convexity of the bone, to be united along with the tendons of the extensors. Their insertion is always at the side of the toe next the great toe, and their use is to bend the first joint of the toes, and to draw them towards the great one, making an arch in the foot, and assisting the transversalis pedis. The FLEXOR BREVIS lies most superficially upon the sole of the foot, having its origin from the inner surface of the aponeurosis. The MASSA CARNEA lies deeper, having no origin but from the tip of the heel-bone, and being soon implanted into the tendon of the long flexor. The LUMBRICALES again rise from the tendons of the long flexor, beginning just where the massa carnea ends in it; and the LUMBRICALES are the flexores primi internodii; the SHORT FLEXOR MUSCLE, the flexor secundi internodii; the LONG FLEXOR, the flexor tertii internodii digitorum.

Lumbricales.

Or. tendon of the flexor longus.

In. side of the first phalanges.

EXTENSORS OF THE TOES.

Extensor longus digitorum.

CXCVI. The EXTENSOR LONGUS DIGITORUM PEDIS is very difficult to dissect, from its numerous adhesions.

Or. 1. upper and outer part of the head of the tibia, 2. almost the whole length of the fibula, 3. interosseous ligament, 4. the fascia.

It arises properly from the head of the tibia, at its outer and fore part, just under the knee; but it has also strong adhesions to the inner surface of the fascia, to the tendinous partitions betwixt it, and the tibialis anticus before and betwixt it, and the peronæi behind, and also to the interosseous ligament, and to the edge of the fibula. Its small origin soon becomes thick, and is divided even from the beginning very perceptibly into three distinct portions. These soon form three round tendons, which go obliquely inwards, pass under the annular ligament of the ancle, and run in a ring of it, peculiar to them and the peronæus tertius. They then traverse the two bands of the annular ligament, upon the fore part of the foot, and now they change their direction a little, and go from within outwards, and diverge towards their proper toes. There are three portions of muscle, and four toes to be moved; the first portion divides its tendon into two, at the joint, so that the first portion serves both the first and second toe, the second the third toe, and the third serves the fourth toe. Here the tendon of the long extensor receives four other tendons; first, of the interossei externi; secondly, of the interossei interni; thirdly, of the long flexor; fourthly, of the lumbricales; and these form a very large sheath, quite surrounding the toe.

In. base of the first phalanx of four toes, continued over the toes.

Extensor digitorum brevis.

CXCVII. The EXTENSOR DIGITORUM BREVIS is so connected with the extensor longus, that it is natural to describe them together. It is placed just where the buckle lies, upon the rising of the foot, having its origin from the heel-bone, and running obliquely inwards.

Or. 1. outer and fore part of the os calcis.

Its origin is from the outer side, and fore part of the heel-bone, and also from part of the annular ligament. It is smaller where it arises by a short tendon

from the heel-bone, but it gradually increases in size: it divides early into four heads, which are muscular, and very distinct; the two inner of which are larger, the two outer more slender: each head has already formed an oblique tendon under its flesh, which begins to appear naked about half way down the metatarsal bones. These tendons cross those of the long extensor, and pass under them nearly about the end of the metatarsal bones. Then one is implanted into the first bone of the great toe, on the inside of the long tendon under which it had turned. The second, third, and fourth tendons are inserted into their respective next toes, and the little toe is left without one. The three last of these tendons form a sort of slit, the two sides of which pass along the sides of the toes, surrounding the long tendon, something like a perforatus; so that the three last tendons are inserted along with the long tendons into the last bone of the toes.

& annular ligament.

In. phalanges of all except the little toe.

The obliquity of this short muscle counteracts the obliquity of the long; and it serves to extend and to spread the toes, and to pull them away from the great toe.

CXCVIII. The EXTENSOR POLLICIS PROPRIUS is a very slender muscle, running from the top of the leg to the second joint of the great toe. It arises from the fibula, a little below its head, takes fibres from the interosseous ligament, grows tendinous as it approaches the foot, then, passing under the annular ligament, and the cross ligament of the foot, it goes onwards to the second joint of the toe over the first.

Extensor pollicis.

Or. from the two thirds of the spine of the fibula, and inteross. lig.

In. last phalanx of the great toe.

The succession in which these muscles lie, under and behind each other, is this: first, the tibialis anticus, the outermost muscle, arises from the fore part of the tibia, nearest the fore part of the leg, at the ridge of the tibia; secondly, the extensor pollicis lies immediately behind and under the tibialis anticus; thirdly, the extensor digitorum communis lies behind that; and, fourthly, the peronæus tertius lies behind the common extensor, like a part of that muscle.

These extensor tendons are bound down by cross bands, resembling the annular ligaments of the wrists. The general fascia of the thigh is continued over the knee, and down the leg; it is much strengthened at the knee, where it adheres to each point of bone; it descends very thick and strong over the leg, binding down and strengthening the tibialis anticus and extensor muscles. The sheath grows thinner towards the ancle, but where it passes over the joint it is so remarkably strengthened by its adhesions to the outer and inner ancles, that it seems to form two distinct cross bands, which, going from the point of the outer ancle, across the extensor tendons, to the point of the inner ancle, forms a strong crucial ligament, resembling the annular ligament of the wrist; so that this, which is called the CRUCIAL LIGAMENT of the ancle or foot, is plainly but a strengthening of the common sheath.

The remaining muscles in the foot are the INTEROSSEI, which, in the foot, are found single on the lower surface or sole, but double, and two-headed, upon the upper part of the foot. The ABDUCTOR, FLEXOR, and ADDUCTOR POLLICIS, which surround the great toe, something like those of the thumb; and the ABDUCTOR and FLEXOR MINIMI DIGITI, surrounding the little toe; and there is a small slip of muscle, the TRANSVERSALIS PEDIS, which goes across the sole of the foot.

Abductor pollicis.

Or. os calcis and lig. of the naviculare.

CXCIX. The ABDUCTOR POLLICIS arises, by very short tendinous fibres, from the knob of the os calcis, and also from a ligament which stretches from this knob to the sheath which belongs to the tibialis posticus; and it arises also from the tendinous partition betwixt it and the short flexor of the toes; and although it forms a tendon beginning opposite to the cuneiform bone, the tendon is not naked, till it has reached the middle of the long metatarsal bone. It unites with the short flexor of the same toe, and is inserted into the first bone or phalanx of the toe at its root, and os sesamoideum. Its use is to pull aside the toe, and at the same time to bend it a little; it also

*I*o. sesamoideum intern. and 1st phalanx.

curves the foot itself, for a joint, or any loaded part, is much better supported by muscles than by ligaments; and this arch requires support more than almost any other part.

CC. Flexor brevis pollicis. This muscle is much shorter than the last, and lies betwixt the abductor and the adductor; it lies immediately upon the metatarsal bone. Flexor brevis pollicis.

Its origin is by a pretty long tendon from the heel-bone, and from the os cuneiforme externum, by two separate slips from the heel-bone, being a full inch in length; it also adheres to the membranous partitions on either side of it. It is soon divided into two heads; one goes to the abductor, and the other goes to the adductor, to have the tendons inserted with theirs into the root of the first bone or phalanx. These tendons contain the sesamoid bones; and the parting of the two heads makes a channel for the tendon of the long flexor to run in. Or. os calcis and cuneiforme externum. In. ossa sesamoida.

Its use is to bend the first joint of the great toe.

CCI. The adductor pollicis is the third and last portion of the muscle which encircles the great toe. Adductor pollicis.

It arises from the heel-bone by a tendon as long almost as that which it gives the abductor: it does not immediately arise from the heel-bone: but there is a ligament extended from the heel-bone to the os cuboides, and it arises from that ligament: this is the ligament under which the tendon of the peronæus longus glides. It takes likewise an origin from the cuneiforme externum. The adductor is divided into two fleshy fasciculi or heads; these unite, and, going obliquely inwards, are inserted either into the sesamoid bone, or directly into the first bone of the great toe. Or. os calcis, cuboides, and cuneiforme externum. In. sesamoideum externum.

CCII. The transversalis pedis extends transversely across the sole of the foot, at the head of the metatarsal bones; it is a very small muscle, and resembles a good deal the palmaris brevis. Transversalis.

It arises from the fore part of the metatarsal bone of the great toe, and the sesamoideum internum, and Or. metatarsal bone, and os sesa-

moideum of the great toe. is inserted into the under and outer part of the anterior extremity of the metatarsal bone of the little toe and ligament of the next toe.

In. metatarsal bone of the little toe, and ligament of the tarsus. Its use is said to be, to make a sort of gutter in the foot, by drawing the heads of the metatarsal bones together; but is it not evident that this is one of many instances of muscles being a more perfect support than ligaments? — It is a support, having a sort of intelligence, contracting or relaxing, according to the necessity or degree of force; indeed, except this use, it is not easy to assign any, for there is very little occasion for hollowing the foot in this direction.

Abductor min. dig. CCIII. The ABDUCTOR MINIMI DIGITI, like the abductor pollicis, is a pretty long muscle, but very slender, lying on the outer side of the foot.

Or. os calcis and lig. Its origin is from the knob of the heel-bone, and from the tendinous septum, which covers the flexor brevis: it forms two small tendons in the same direction: one small and shorter tendon is fixed in the metatarsal bone, at its root: the other goes forward *In.* root of the first bone of the little toe. to be inserted into the root of the first bone of the toe, so that this muscle clearly performs both the offices ascribed to the other flexors. It bends the toe to which it belongs, and it extends and supports the tarsus in walking; and it carries the toe a little outwards, from which it has its name.

Flexor brevis min. dig. CCIV. The FLEXOR BREVIS MINIMI DIGITI is next, and is almost the same muscle in place and office: it *Or.* 1. metatarsal bone of the little toe. 2. os cuboides. is an exceedingly small muscle; it just measures the length of the metatarsal bone, and arises from it. Its origin is from the root of the metatarsal bone of the little toe, and from the ligament by which that bone is connected with the os cuboides; its small belly *In.* root of the first bone of the little toe. runs the length of that bone, and it is implanted by a short tendon, into the root of the first bone of the little toe.

Its use is to bend the toe.

Interossei interni. Same as in the hand. CCV. The INTEROSSEI INTERNI are three small muscles seated in the planta pedis, as the interossei manus are in the palm of the hand. Their slender

tendons pass through the openings of the aponeurosis plantaris, and, going on the inside of the toes, are, like the lumbricales, inserted along with the extensor tendons.

These pull the toes towards the great toe, bend the first joint, and extend the second and third.

CCVI. The INTEROSSEI EXTERNI are, like the corresponding muscle of the hand, four in number, and double headed, and have been named bicipites. They rise from the metatarsal bones, on each side of them: each has some little variety in its origin or course; but it is far from being worth our while to describe each individually, as many do: it is sufficient to observe their origin, and that their tendons all meet the tendons of the long and short extensors of the LUMBRICALES, and of the INTEROSSEI INTERNI, upon the backs of the toes; so that the whole forms a web, aponeurosis, or sheath, which covers the upper part of the toe, and adheres to its point.

Interossei externi. Same as in the hand.

The office of these muscles is to extend the toes.

FASCIA OF THE LEG. — The dissection of these muscles on the fore part of the leg and foot is somewhat difficult from the relations of the fascia. This fascia is a continuation of that of the thigh, for we trace that membrane over the knee-joint, as I have said, into the tibia. But from the spine of the tibia it takes a new origin, and, as it were, renews its strength. It not only covers the tibialis anticus and extensor muscles, but sends strong septa betwixt them. Its obvious use at this point is to give attachment to the muscles, and to afford that origin which the bone cannot do but through its intervention. Here, during the dissection, it will be seen, that the FASCIA is very erroneously described as a COVERING to the limb, since it dives betwixt the muscles, and gives off connections to the bones and deeper membranes. While a superficial fascia covers the gastrocnemius and the tendo Achillis on the back of the leg, another layer slips under these, and, having connection with the bones, covers the tibialis posticus and flexors.

Towards the ancle on the fore part, the fascia is strengthened by strong tendinous fibres, so as to form the annular ligament at this point; and from this it is stretched over the dorsum of the foot to the toes.

PLANTAR APONEUROSIS.—The palm and the sole are much exposed, and are especially defended by a thick tendinous aponeurosis. In the palm, there is the more reason to suspect expansion to proceed from the tendon of one muscle, because the tendon of the palmaris is inserted into it; yet that is not probable; for the tendon is very slender, and quite unfit for the generation of so broad a sheet of aponeurosis. In the foot, such an origin is still less probable; for the plantaris tendon does not terminate in the plantar aponeurosis, but is inserted into the heel-bone.

The plantar aponeurosis arises most distinctly from that part of the tuber of the heel-bone upon which we stand: it is divided into three sheaths. Sabbatier makes a middle, external, and internal portion of the same aponeurosis. Albinus also describes it as three distinct aponeuroses; one for the middle of the foot; one for the abductor of the great toe; and one the aponeurosis of the abductor of the little toe; all connected together only by their edges. Cowper considers it as a general expansion from the plantaris; and it is from this prejudice that the muscle has its name.

But its true origin is from that part of the knob of the heel-bone on which we stand. The middle and more pointed tendon arises from the very point of the knob. The inner fascia arises from the inside of this; and the outer one from the outside. And though thus divided into three heads, yet the whole origin is from the heel-bone. From this point the aponeurosis goes forward expanding till it is as broad as the roots of the toes; so that the whole has the shape of a sandal; and as it expands, its fibres are scattered, so as to have a radiated appearance. Accordingly, the part nearest the heel is thicker, while the broader part is thinner.

It goes forward like the sole of a shoe, till having approached the heads of the metatarsal bones, it is divided into five heads, corresponding with the five knobs; and each of these heads again subdivides itself into two bands, which, passing on each side of the heads of the metatarsal bones, is fixed into the sides, so as to leave room for the passing of the tendons, and nerves, and arteries.

Now this middle aponeurosis sends down a deep strong partition on each side of it; which is the best reason that I know for making these three distinct aponeuroses; for by these perpendicular partitions, the hollow of the foot is separated into three distinct chambers: under the middle one are concealed the tendons of the long flexors, with the lumbricales and short flexor muscles: under the outer one the flexor and abductor of the little toe: and under the inner one the abductor, flexor, and the abductors of the great toe.

The uses of this great and very strong aponeurosis are: that it protects all the parts, the blood vessels, muscles, and nerves that lie under it: that it supports the arch of the foot, both in standing and in motion, passing from heel to toe like a bow-string across its arch: that it binds down the muscles, and consequently supports and assists them in their strong actions: that it gives origin, or part of their origin, to many of the muscles; which, by their frequent and irregular adhesion to it, are very difficult to dissect: that it forms openings or rings, in which the tendons of the other muscle pass.

OF THE MUSCULAR POWER.

That contractile power which resides in the muscular or living fibre, is a phenomenon the most wonderful and perplexing of all. When we cannot reach the true point, the mind too often condescends to the most trifling pursuits; and so, when the older physiologists could not understand the

intrinsic nature of this muscular power, they endeavoured to discover the size, the colour, and other external properties of the fibre: foolishly desiring to know what, if known, could be of no avail. Colour was believed to be essential to the constitution of a muscle: but in fowls, in amphibious animals, in fishes, in worms, and insects, through all the gradations of animals of different species or different sizes, the colours of the muscular fibre change. In fishes and in insects, it is entirely white; even in the human body, it is not essentially red: the blood which makes the fibre red may be washed away. Then why should we define a muscle by that accidental property which it so often wants, and of which it may be so easily deprived, while we may define it more truly by its contractile power, the only evidence of its nature, and its chief distinction in the system? for the contraction of the iris constitutes its nature; it is a muscle by truer marks than by its colour: and, by the same rule, the muscles of the least insect are as perfect as the muscles of a man.

Philosophers of the last age had been at infinite pains to find the ultimate fibre of muscles, thinking to discover its properties in its form; but they saw just in proportion to the glasses which they used, or to their practice and skill in that art, which is now almost forsaken. Some found the fibres to be of one equal size in all creatures, however various: others found them proportioned to the size, or age, or strength of their subject; but even such discrepancies are trivial to those which, in one of the greatest of these minute philosophers, are found almost in the same page; sometimes affirming the ultimate fibre to be greater or smaller, according to the strength of the subject, and again making them of equal size in the whale and in the insect.

Others, less troubled about the size of these ultimate fibres, had conceived notions of their form, which, in the credulity of the times, rose into the importance of doctrines, and, from the first raw conceptions of their authors, were finally proved by the

microscope, forsooth; and while one author was drawing his rhomboidal fibres, all conjoined in regular succession; and another describing them also from the microscope, as consisting of six cylindrical fibres, involved in a spiral one, a third was reckoning the fibres as a succession of spherical bodies: and Cowper thought that he was injecting with quicksilver chains of bells jointed with each other. For the honour of the age, these vanities are forgotten now.

Physiologists have, by a late sense of their own weakness, been at last humbled to this becoming, but unwilling acknowledgment, that this contractility of the muscles is an original endowment of this living matter derived from the Creator, imparted in a way which we cannot know, and so attached to the organization of the muscular fibre, that where its organization is destroyed this power is lost. We have resigned the search after a mechanical or physical cause, and seek only to learn the properties of this living power, and the excitements by which it is moved. To this end it is necessary to define this power, distinguishing it from these feelings or motions which result from the nerves. The vis insita is that power which belongs to muscles, and is the source of motion. The vis nervea is that property which is peculiar to nerves, and is the cause of voluntary motion. They convey the will to the muscles, but are incapable of motion.

This irritable power residing in muscles may be defined to be the property by which muscles feel and re-act, upon certain stimuli being applied; and that, while certain orders of muscles are obedient to their own stimuli only, as the heart to the blood, the bladder to the urine, other orders of the muscles are ready to receive the commands of the will. This power, inherent in the muscular fibre, belonging to its constitution, and not derived from without, is the vis insita, or irritability of Haller*, the vis vitalis of Goerter, the oscillation of Boerhaave, and the tonic

* The irritability of a muscle is, perhaps, more properly the vis insita, or inherent power, called into immediate action by the

power of Stahl. It is seen in the spontaneous and tremulous contractions of muscles when lacerated, as in wounds, when cut in operations, when entirely separated from the body; as in experiments upon animals, like that tremulous motion which we often feel in various parts of the body, without any evident cause, and independent of the will. Even when the body is dead to all appearance, and the nervous power gone, this contractile power remains; so that if a body be placed in certain attitudes, before it be cold, its muscles will contract, and it will be fixed in that posture till the organization yields and begins to be dissolved; it is the same inherent power by which a cut muscle contracts and leaves a gap. This is but a faint indication of that latent power, which can be easily excited to the most violent motions, and on which all the strength of the muscles depends: for the ligaments, tendons, bursæ of joints, and all those parts which have no such power, are capable of bearing the same weight when dead as when alive. But such is the dependance of the muscle on this vital endowment, that the moment it dies its power is gone; and the muscle which could lift a hundred pounds while alive, cannot bear the weight of a few pounds when dead. This latent power may be brought into full action by various stimuli. The latent power itself is called vis insita; the acting power put into action, or the proof of the vis insita, upon applying stimuli, is called the irritability of muscles.

Authors have doubly confounded the power of the muscles and the nervous system, by observing that the muscle continues to act when separated from the brain by the division of its nerves. It would be easy to shew that there can be no such separation of

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presence of stimuli; and as for the names of Tonic Power, Vital Power, and the rest, the terms are quite undefined, and may, perhaps, have referred rather to the combined effect of all the powers of life, and of all the properties of inanimate matter, of nervous sympathy, elasticity, and of muscular power combined.

the muscular and nervous systems, and that when the muscle is even cut out, and exhibits contractions, these phenomena do not belong to the muscle, exclusively of the nerves. Anatomy teaches us that the nerves meet every where with the muscular fibre, and to separate them is impossible. Have we not learned that every fibre of muscle has its sheath, and that it lies insulated from every other fibre: what then is the influence which combines a million of fibres in one simultaneous action? If a muscle so cut out be pricked, and acts, does it not imply that every fibre sympathizes; and what other bond can unite them but the nerves?

Upon stimulating any muscle by touching it with a caustic, or irritating with a sharp point, or driving the electric spark through it, or exciting with the metallic conductors, as of silver and zinc, the muscle instantly contracts; although the nerve be cut so as to separate the muscle entirely from all connection with the system, although the muscle itself be separated from the body, although the creature upon which the experiment is performed may have lost all sense of feeling, and have been long apparently dead. Thus, a muscle cut from the limb trembles and palpitates long after; the heart separated from the body contracts when irritated; the bowels when torn from the body continue their peristaltic motion, so as to roll upon the table, ceasing to answer to stimuli only when they become stiff and cold. And thus the eye is sensible, and the skin is sensible; but their appointed stimuli produce no motions in these parts; they are sensible, but not irritable. The heart, the intestines, the urinary bladder, and all the muscles of voluntary motion, answer to stimuli with a quick and forcible contraction; and although they feel the stimuli by which these contractions are produced, they do not convey that feeling to the brain. The muscular parts have all the irritability of the system; while nerves have all the sensibility of the system, and have the power of exciting motion without the power of motion.

The VIS INSITA is a power that is in continual force, preserving the parts ready for their proper stimuli, whatever these may be; one set obeying their own peculiar stimuli, while others are obedient to the influence of the will. The heart is stimulated by the quantity of its blood; the stomach by the presence of food; the intestines by their contents: the urine stimulates the bladder; the venereal appetite stimulates the genital system; the fœtus stimulates the womb; and the voluntary muscles (if we may be allowed to guess at a thing so little known) are excited by the voluntary nerves, and so are obedient to the will; for, to our limited view, the nerves seem to be the sole messengers of these commands, and any stimulus to the nerves moves the muscles like the commands of the will. The absence of the due stimulus to each, or the presence of the ordinary stimuli in too great power, will excite irregular motions, as fulness of blood in the heart, poisons in the stomach, acrimonies in the intestinal canal, or the passions of anger or fear in the system of the voluntary muscles. The due stimuli preserve their right tone and action; but these violent stimuli hurt their irritability, or moving power; the heart acts weakly after fevers; the appetite is languid after debauch; the limbs are weakened by labour; and the whole system is ruined by excess. Thus, the functions by which the system lives, the heart, the stomach, the bowels, and the womb, the various sorts of vessels by which the fluids are conveyed, are providently removed from the influence of the will; for these are the machines of the system, whose motions could not stop, must not be interrupted, nor lowered, nor raised, but must move and act according to the needs of the system. Not left to the irregularities or carelessness of voluntary motions, they are governed each by its own peculiar stimulus, and act in a continued and equal course.

Thus, there are in the body two living powers, which are as cause and effect in all the motions of our system. The NERVES stand as an intermedium betwixt all external objects and our general sense;

by the impressions through these come pleasure and pain, and all the motives to action; by the will, returned through other nerves, all voluntary motions ensue. Thus are the nerves, as internuncii, betwixt the external impression and the moving power. But nerves were never known to move under the influence of stimuli; the moving power is another property of a distinct part of our body, having its own arrangement of particles, and its own peculiar form. All motion, then, proceeds from the joint operation of either power; the nerves convey the impressions, while the muscles contain the power; and it is here, as in other natural effects, the external cause changes, while the inherent property, the subject of its operation, remains the same. Some have, with reason, supposed that the nervous power is the regulator of the system; it is the property suited to all the supports of life, upon which they act, and by which they maintain their power over our body; but is subject to continual changing: it rises and it falls, is perfect or low; but the energy of the muscle, which is to answer to this power, remains ever the same, while its organization remains: the nervous power is exhausted and languid; but the muscular power is always perfect, always ready for the excitement of stimuli, or for the commands of the will.

The irritability, or inherent power, not only keeps the muscles ready, each for its peculiar stimulus, but preserves a balance over the whole system of the muscles. We know that muscles maintain a constant action. The muscles of one side balance the opposite muscles; and if the muscles of one side be relaxed by palsy, the action of the opposite muscles instantly appears; or if a limb be luxated, and its muscles displaced, they persevere in a violent and spasmodic action, till they be restored each to its place. Have we not reason to believe, that if muscles were absolutely and entirely quiescent, they could not be so instantaneously called into action; but that by this continual tension or tone, they more readily follow the commands of the will.

We naturally revert in this place to the sound opinions of Mr. Hunter, who, speaking of life, distinguishes the properties or actions of parts into two, those which regard their own preservation, and those which regard the general economy. These latter may be interrupted as by suffocation; but if the powers of the separate parts remain, we may produce resuscitation and reanimation, by restoring the corresponding sympathies. It is the remains of contractile power which fixes the dead body in whatever posture it is placed: it is this remains of irritability, which preserves freshness in the animal which seemed dead; but which is really dying still: for the moment this lingering portion of life is gone, the body dissolves, and falls down; and so we judge of freshness, by the rigidity of the flesh, and foresee approaching putrefaction, by its becoming soft. The fish, which is allowed to struggle till it be dead; the ox, over-driven before it be brought to the slaughter; the animal killed by lightning, which suddenly explodes (if we may be allowed the expression) all the powers of life; in these the contractile power is effectually destroyed or lost by the entire death. The life stopped all chemical decomposition, but now putrefaction comes quickly on. In those who die of the plague, of poison, of fevers, or of any sudden and violent disease, which at once extinguishes life in the vulgar sense, and robs the system of that remnant of life, which the physiologist could produce to view; in all these cases, the body becomes putrid in a few hours.

And here we are led to observe a fact of great consequence to the Pathologist; the muscles are not equally under the influence of the sensorium; some are prompt and exact, under the guidance of the will, whilst over others we have no command at all; and there are not a few which we command indirectly, that is, we put a certain class of muscles into operation, which are followed by the combination of others, over which we have no direct power. And as the muscular system is thus connected with

the sensorium in different degrees, so we might be led to expect that these muscles might be differently influenced when the mind is oppressed. In fact, in proportion as the muscles are more or less immediately under the guidance of the will, so they are affected when the brain is oppressed. This we may see in the approach of natural sleep, or in the effects of intoxication. The influence steals over the eyes, the countenance, and the limbs, until the vital operations of respiration and circulation are all that remain.

But, before dismissing this subject, we must present the muscular system in a different view from what has hitherto been taken of it. The voluntary nerves, which controul the muscular system, are sensible of the degree of activity assumed by these muscles, and there is thus a universal sense spread over the body, which ministers to the proper organs of sense, and is, itself, more important than them all. It is by this property in the voluntary nerves and muscles, that we are enabled to balance the body in standing, walking, or running; adjusting the muscular action, and the state of tension of the limb, to the gravitation of the body, and so sustaining it in every variety of posture. We see with what pains, and after repeated efforts, the child acquires this power; and we see how a man is deprived of it in sickness or inebriety: whilst the utmost perfection of the same power is exhibited in the rope-dancer. And what we are thus led to contemplate in the whole body, may be noticed in the hand, in subserviency to the sense of touch; in the tongue, as subservient to mastication; in the eye, in aid of vision. It is this faculty which gives us the impression of resistance, and consequently of weight, of solidity, of fluidity, roughness, smoothness, angularity, &c. Thus, a man deprived of his sense of touch in his arm and hand, has continued in possession of the muscular power, and of the sense of muscular exertion, and, therefore, he could form an estimate of the weight of what he held in his hand,

Here then is truly that power which gives us the most accurate perception of things external to the body, and of all those qualities which would induce us to call this the geometrical sense; a term which has hitherto been given with little propriety to the sense of touch.*

As for the MECHANICAL POWERS, by which the contractions of the muscular fibre is forwarded or retarded, they are not what they have been believed; for we find few circumstances in the origin, insertion, or forms of muscles, to favour their power, but many by which their power is abridged. There are certain points where the length of lever gives an increase of power. The mastoid process, and the occiput are as levers for the head; the spines of the vertebræ, for the back; the olecranon, for the arm; and the pisiform bone, for the hand. The pelvis and the jutting trochanters are as the levers for the thigh; the patella is a lever for the leg; the heel-bone is a lever for the whole foot; and the arch of the foot is as a lever for the toes. These are not the whole, but they are, perhaps, the chief levers in the human body. In all the other implantations the muscle is fixed, not behind the joint, but betwixt the joint and the weight that is to be moved. There is a greater loss of power, when inserted near to the joint: there is less loss of power, when the tendon is inserted far from the joint, and though we call such insertion a longer or shorter lever, there is always some loss of power, and the true levers in the body are very few; far from providing mechanical forms to increase the power, nature has provided such a quantity of contractile power as to compensate for any loss of effect: so, in place of increasing the effect of muscles by levers, pulleys, and hinges, there is in almost every muscle a great abatement of its force, by the form of the bones which it is destined to move: for muscles lose of their effect, by their being implanted, not behind the joint, but

* See the *organs of the senses*.

betwixt the joint and the body to be moved; by the insertion of almost all muscles being very oblique, with respect to the motions which they are to perform, so that half their force is lost upon the immoveable end of the bone. Much force is lost by a muscle passing over many joints: one set of fibres in a muscle hinders the action of adjoining fibres, and every degree of contraction takes from that muscle an equal proportion of its power. Thus, every where in the human body is power sacrificed to the form and fitness of the parts, that the joints may be smaller than the limbs; that the limbs may be proportioned to the body: and beauty, convenience, and velocity of movement are gained by the sacrifice of that power, which is not needed in the system, since the wisdom and goodness of the Creator has appointed a degree of force in the muscles, more than proportioned to all this loss of the mechanical power. Those who will admire the ways of Providence, should know how to admire! Nature is not seeking to compensate for want of power, by the advantages of pulleys, and levers, and mechanical helps; nor is it in the forms of the parts, that the Infinite Wisdom is to be found: for among other gifts, such a portion of this spirit is given to man, that he has used the pulleys and levers, accelerations of motion, and all the mechanical powers that result from it; he has invented valves of infinite variety, each perfect and true, to its particular office; he has anticipated all that he has found in the mechanism of the human body; but the living power which compensates for the want of levers, which allows every where power to be sacrificed to the beauty of form, which has strength, in convulsive and violent actions, to break the very bones, — this is the act of Infinite Wisdom, on which our admiration should chiefly dwell. It is but the very elements of so deep a subject that can be delivered here.

OF THE CELLULAR SUBSTANCE.

OF THE MEMBRANES, &c.

The subject of this chapter offers some very interesting facts to our observation, and is both curious and useful. It is necessary to a correct notion of physiology, and forms the very foundations of pathology. The offices of the cellular substance is so important to life, the changes which it undergoes in the natural course of life, the remarkable alterations wrought upon it by inflammation, render it an important part of any general system of anatomy.

In treating of it, we have an opportunity of doing justice to our countrymen who have left their reputation to be guarded by us, and of correcting that disposition of our youth, who, in search of foreign novelties, lose sight of the brighter examples they have at home.

As we advance in our knowledge of the animal economy, it becomes every day more difficult to define the difference of solid and fluid; since in a living body they are continually alternating; and since part of that which is fluid in the living body becomes solid in the dead.

Before describing what a membrane is, we must point to the peculiarities of the *cellular membrane.*

In cutting through the skin the cellular membrane appears with its most common properties. First of all, let the student distinguish it from the fat or *adipose membrane.* The cellular substance or cellular tissue (*tela cellulosa*) consists of thin membraneous processes, which constitute cells or little cavities. The sides of these cells are bedewed with a fluid, which, like that of a joint, lubricates, and produces a fitness for motion, the intention being that the membranes forming these cells should shift, and stretch, and accommodate themselves to the motions of the frame. These cells communicate freely together. The anatomist traces this cellular

tissue every where: it is distinct under the skin; it is still more loose and free among the muscles; it enters into the composition of every part: for as there must be every where a capacity of motion, as even the solid viscera must have their pulsating vessels, they must possess elasticity, and their mobility and resiliency is given to them by the proportion of cellular texture which enters into their composition.

These membranes, thus forming a continuous series of cells, may be traced into every part; we have seen it in the bones, around the earth of bone; we have seen it forming the sheath for the muscles; and in a similar manner, though more delicate in its texture, it enters into the brain and the eye, and the nerves; giving support to all the most delicate organs of the body.

The cellular substance is common to animal and vegetable bodies; and whatever notions we find to have prevailed in any age with the physiologists of one department, the same is expressed by the authorities in the other. Du Hamel asserts that the membranes of vegetables are composed of organic fibres arranged parallel to each other, and united by a glutinous substance. Haller's first word is *fibra*, the element. As the length is to the geometrician, the fibre is to the physiologist, — out of it he constructs the other parts. At present there is an attempt, which I consider equally trifling, to describe the elementary fibre of the animal body, and to make this fibre to be formed of globules of a certain diameter, ($\frac{1}{300}$ of a millimetre.) The error I apprehend to be in supposing the fibre to be the elementary part, instead of the membrane.

Fluids precede the formation of the solids; we would liken it to a soap bubble, which assumes a solid and concrete form, and which by maceration may be again dissolved. A principle of vitality preserves the membrane in its state of aggregation, and with the loss of life it dissolves — not into mechanical constituents, but into its chemical ele-

ments. This vital quality in membranes is shown by the property of the membranes to retain and keep separate juices or coloured fluids of an opposite quality. In the living body there is no transuding of smell or colour. The intestine, in hernia, does not taint the fingers, as the same intestine will do in the dead body. The bile in the living body is retained within the membrane of the gall bladder; in the dead body it stains every surrounding part by transudation. So, if we cut across a living plant, we see the juice, of the most opposite nature and perfectly different colour, flowing from distinct tubes or cells, and separated by their membranes. I state this circumstance to show that the simplest form of membrane has life inherent in it; qualities which do not result from the fineness of its texture, but from possessing a quality different from dead matter; the same quality which retains it in its proper state of aggregation and organization, and which when deprived, leaves it to resolve into its elements.

In opposition to the continental authorities, headed by the celebrated Bichat, I would teach, that instead of original molecules and elementary fibres being traced into membranes, membranes are the original and simplest form of the animal frame; and that the parts which the French physiologists call fibrous parts, are really not so, but are, on the contrary, resolvable into membranes. They would have us to believe the tendons to be fibrous; whereas nothing is easier than to resolve them by maceration into cellular texture.

Besides, instead of witnessing any thing like the weaving and intertexture of their fibres, as if there were a warp and a woof in the membranes of the body, we see them, in fact, formed very differently; we see a fluid effused, as upon the lungs, coagulating; we see this coagulum becoming vascular; we soon discover it to have become a mass of cellular texture formed of membranes; and we find, if it continue, that this texture will at length form cords of adhesion and

connection betwixt the surfaces, as firm as any cord, and of the texture of a true tendon or ligament.

In the same way we may see the membranes formed by incubation in the egg; or we may see the gradual change taking place as the embryo advances. At first, it looks like a transparent jelly, in which there are no distinction of parts; and gradually we see in the mass white membraneous partitions, as afterwards we see bones and muscles, &c.; but in all this there is nothing to countenance the idea of an original fibre wrought into the several textures of the body.

If any thing more were wanting, we have it in the degeneration of the fine provisions and proportions of a joint. Let this joint become inflamed, or merely stopped in its motion, as in anchylosis, and instead of ligament and tendon, fascia and cartilage, synovia and bursa, and all the fine mechanism of the articulation, you find nothing but the loose cellular texture. Or, refusing this analytical procedure, we may view it synthetically; for if a bone be broken, and that bone, instead of uniting, be permitted to dangle loose, it will become an artificial joint; and out of the common cellular membrane, and the coagulable lymph discharged by the inflamed vessels, there will be formed membranes and ligaments, and even cartilages and the other appurtenances to a joint.

These considerations make me reject this weaving system, as unsuitable to the taste of this country, and quite at variance with what pathology as well as the natural anatomy discloses to us.

We shall resume this subject in speaking of the membranes of the different cavities. At present we have only to understand, that these extended sheets of animal matter called membranes, have this common character through the whole body: 1. That they have one surface smooth, and bedewed with a secretion that prevents the surface adhering, and which is favourable to the motion of that surface. 2. That the other surface of the membrane is adhering and rough, being in truth of the nature of the common

cellular texture. 3. That these membranes have no termination, but, on the contrary, you may trace them on from one part of the body to another interminably, unless where they form the shut sacs, that is, the lining membranes of cavities, when, of course, they are continuous with themselves.

OF THE TENDONS, LIGAMENTS, BURSÆ, AND FASCIÆ, AND ALL THE PARTS WHICH BELONG TO THE BONES OR MUSCLES, OR WHICH ENTER INTO THE CONSTITUTION OF A JOINT.

The bones and muscles themselves are but the smallest part of that beautiful mechanism by which the motions of the human body are performed; for the parts by which the bones are joined to each other, or the muscles fixed into the bones, are so changed, and varied in their forms, according to the uses of each part, as to give a natural and easy shape to the limbs, security and firmness to their motions, and lubricity and smoothness to the joints by which these motions are performed; and this apparatus deserves our attention, not merely that we may know the forms of these joinings, but that we may learn something of the nature and uses of each part, and the various degrees of sensibility with which each is endowed; for, from this kind of study, conclusions will arise, which may lead us to the knowledge of their diseases, suggesting the means of their prevention and cure.

There is a difference in the parts of the human body, according to the several uses for which they are designed; some are vascular and soft, others bony and hard; some sensible, and very prone to inflammation and disease, others callous and insensible, having little action in their natural state, and little proneness to disease.

The active parts of the system, as we have stated in the introduction, are the muscles and nerves; the

muscles to move the body, and perform its offices, each muscle answering to its particular stimuli, and most of them obeying the commands of the will; the nerves to feel, to suffer, and to enjoy, to issue the commands of the will, and to move the muscles to action: but there is a substance which joins these parts and connects arteries, veins, nerves, and muscles, and performs for them every subservient office, forms coverings for the brain, coats for the nerves, sheaths for the muscles and tendons, ligaments and bursæ, and all the apparatus for the joints; unites them by a continued tissue of CELLULAR SUBSTANCE. The tendons, ligaments, periosteum, and bursæ, may be considered as composed of this cellular substance.

OF THE FORMS OF THE CELLULAR SUBSTANCE.

Under various modifications and shapes, the cellular substance performs most important offices among the living parts:—1. It forms CELLS over all the body, which allow the parts to glide and move easily, which contain the fluid that makes all the motion of parts more easy and free. This cellular substance is peculiarly useful to the muscles, dives in among them, keeps their fibres at such due distance that each may have its action, supports and lubricates them; so that perhaps the difference of strength, in health and disease, depends, at least, in some degree, upon this support. The interstitial cellular substance surrounds the fat cells also. This structure, which is called the adipose membrane, consists of small bags which do not communicate with each other, but are for the deposit of oil or fat. The fat is lodged betwixt the muscles and fills up every interstice; a want of it is a defect, while a superabundance of it encumbers the body and limbs. And Haller seems to have believed, that a diseased increase of it might not only oppress, but almost annihilate the muscular fibre.

2. But it is still farther essential to a muscle, that while it moves, it should neither be hurt itself, nor harm the surrounding parts. Therefore, where one muscle moves over another muscle, soft flesh upon soft flesh like itself, there can be no hurtful friction, and the cellular substance is loose and natural, preserving its common form. But where tendons rub upon tendons, or bones upon bones, or where tendons rub upon muscles, or upon each other, some defence is needed, and the cellular substance assumes a new form. The cells are run together into one large cell, with thicker coats, and a more copious exudation, so that, being more liberally bedewed with a gelatinous mucus, it prevents the bad effects of friction, and is called a BURSA MUCOSA, or MUCOUSbag. These mucous bags are placed under rubbing tendons, and chiefly about the greater joints; some are large, and others small; their glairy liquor is the same with that which bedews the cellular substance, or the cavities of the joints; and the provision of nature is so perfect, that the occasions which require bursæ seem to form them by friction, out of the common cellular substance.

3. It is often useful that an individual muscle should be enclosed in a tendinous sheath, to give it strength and firmness, and to preserve it in its shape, or to direct its force. All muscles, or almost all muscles, form for themselves individual sheaths, such as are seen enclosing the supra-spinatus and infra-spinatus of the scapula, the biceps humeri, the sartorius, and most of the muscles of the leg and thigh; but it is especially necessary that the whole muscles of the limb should be enclosed in some stronger membrane than the common skin, both to give form to the limb, and strength to its muscles, and to keep the individual muscles in their proper places, which otherwise might be luxated and displaced. And so some parts of the trunk of the body, the arm, the thigh, the leg, are bound each with a strong, smooth, and glistening sheath, formed out of the cellular substance, condensed and thickened by continual pressure. It is hardly to be distinguished in the child; grows thicker and stronger as we advance in years and in strength,

and in the arms of workmen it grows particularly thick and strong, increasing in the back, shoulder or limbs, according to the particular kind of labour. These are the membranes, which, by enclosing the muscles like sheaths, are called the VAGINA, or FASCIA of the arm, the leg, the thigh, &c.

4. TENDONS or ropes were needed, for the muscles could not be implanted thick and fleshy into each bone, without a deformity of the limbs, and especially of the joints, which would have been not unshapely only, but which must have abridged them of their motions and uses. Where a muscle is not implanted directly into a bone, tendons are seldom required; and so there are no tendons in the heart, the tongue, the œsophagus, the stomach, intestines, or bladder. But where tendons pass over bones, or traverse the joints, their force is concentrated into narrower bounds; and long tendons are fixed to the ends of the muscles, to pull the bones. These tendons were once believed to be but the collected fibres of muscles gathered into a more condensed form: by which condensation, their properties of feeling and motion were lost, while they became hard, white, and glistening; and it was believed, that parts which were fleshy in the child, became tendinous in the adult. But we know by the microscope, that the tendon is not truly continued from the flesh; that the fibres of the tendon, and of the flesh, are not in the same line, the fibres of all penniform muscles running into their tendon, in a direction more or less oblique: and good anatomists have been able to separate the tendon from the flesh, without any violence, and with the bluntest knives. Muscles are irritable, and have nerves; tendons have no visible nerves, have neither feeling nor self-motion, nor any endowment by which we should believe them to be allied to the muscles or nerves; and many tendons, as the expansion of the palmaris, may be unravelled into mere cellular substance.*

* The tendons are the continuation of the interstitial cellular membrane of the muscle; and I have succeeded in unravelling them into a web.

The TENDON, then, is nothing more than the cellular membrane, which is in the interstices of the muscular fibres condensed together. The tendinous origin of a muscle, for example, may be traced through the muscle from one extremity to the other till it is again gathered and twisted into the tendinous insertion. They may be resolved into loose cellular membranes by maceration, and many tendons may be stretched out into a web even without maceration.

5. The PERIOSTEUM is merely a condensation of the common cellular substance, formed in successive layers: and the tendons are inserted into the substance of the periosteum; they mix with the periosteum, and through it are implanted into the bone. In dissecting a young bone, we tear up the periosteum along with tendons and without hurting the bones: but in process of time, the periosteum, and, consequently, the tendons, are inseparably fixed to the bones. The periosteum, tendons, fasciæ, and bursæ mucosæ, are all of one substance, and of one common nature; they are various modifications of cellular substance.

6. These tendons must be bound firmly down, for if they were to rise from the bones, during the actions of the muscles to which they belong, the effect of contraction would be lost, and they would disorder the joint, starting out in a straight line from bone to bone, like a bow-string over the arch of a bow. The same substance still performs this office also; for the tendons of one muscle often split to form a sheath or ring for the next, or their tendons, after taking hold of the bone, spread their expansion out over all the bone, so as to form an entire sheath for the finger and toe; or there is a wide groove in the bone which receives the tendons, and it is lined with a cartilage, and with a lubricated membrane; the membrane comes off from the lips of the groove, or from corners or edges of the bone, passes over the tendons, so as to form a bridge, or often it forms a longer sheath, as in the fingers, or where the peronæi

muscles pass behind the ancle, and thus the VAGINA or SHEATHS of the TENDONS are connected with the tendons, periosteum, and other modifications of the common cellular membrane.

7. The periosteum which has run along one bone, leaves it at the head, and, forming a bag for the joint, goes onwards to the next bone. Thus, the periosteum of all the bones is one continued membrane, passing from point to point; each bone is tied to the next by its own periosteum, and this membrane, betwixt the end of one bone and the beginning of the next, is so thickened into a strong and hard bag, as to form the capsule of the joint; and the periosteum is assisted in performing this office by the tendons, fasciæ, bursæ, and all that confusion of cellular substance which surrounds the joint. The CAPSULE of the JOINT is then a firm and thick bag, which, like a ligament, binds the bones together, keeps their heads and processes in their right places, contains that glairy liquor with which the heads of moving bones are bedewed, and prevents the adjacent parts falling inwards, or being caught betwixt the bones in the bendings of the joints. The capsule of every joint proceeds from the periosteum, and is strengthened by the tendons; it is formed like these parts out of the cellular membrane; and when a bone is broken, or its periosteum destroyed by any accident or disease, when a tendon snaps across, when a joint is luxated, and the capsule torn, the injury is soon repaired by a thickening of the cellular substance round the breach; and wherever a bone, being luxated, is left unreduced, a new socket, new periosteum, new ligaments, and new bursæ, are formed out of the common cellular substance: and though the tendons may have been torn away from the head of the bone, they are fixed again, taking a new hold upon the bone.

8. There are other LIGAMENTS of a JOINT which prevent its luxation, guarding it at its sides, or round all its circle, according to its degree of motion; and those ligaments are of the same nature

with the first, or bursal ligaments, arise, like them, from the periosteum chiefly, or indeed are truly but a thickening of the bursal ligament at certain points.

The universal connection of these parts is now sufficiently explained, since we have followed the several forms of cellular substance: 1st. Clothing the bones with a thick membrane, which, though insensible, as contrasted with the skin, conveys blood-vessels, the means of life, to the bones, and is named periosteum: 2dly, The same periosteum, thickened and strengthened by the adhesion of surrounding parts, so as to form the capsules for the joints: 3dly, The tendon also continued from the periosteum, and not growing from the muscle, but formed of the cellular membrane: 4thly, We see that smaller tendon, expanded into a thinner tendinous sheet, as in the brawn of the leg where the ham-strings (whose expansion strengthens the knee-joint) go down over the muscles of the leg: 5thly, We see the perpendicular partitions of this fascia going down among the muscles, and dividing them from each other; and the cellular substance, which lies under the fascia, and immediately surrounds the muscle, cannot be distinguished from the inner surface of the fascia itself: 6thly, And as for the bursæ we see that they are formed wherever a tendon rubs over a bone. The upper surface of the bursa is formed by the tendon which rubs over the bone: the lower surface of the same bursa is formed by the periosteum of the bone which it defends: the sides are formed by the common cellular substance. Its cavity appears to be merely an enlarged cell: and the bursæ mucosæ and capsular ligaments are plainly of one and the same nature: their liquors are the same, they often open into one another naturally, or if not naturally, at least it is no disease, since no bad effects ensue.

I must now explain more fully the constitution and nature of all the less feeling parts: for what I have said might be thought to imply absolute insensibility and total exemption from disease or pain:

whereas the sensibility of tendons, ligaments, bursæ, and joints, stands on the same footing with the feeling of bones: they are insensible in health; not easily injured; entering slowly into disease; but their diseases are equally dreadful from their duration and from their pain: for by inflammation, their organization is deranged, their healthy consistence destroyed, and their sensibility excited in a dreadful degree.

The tendons of animals have been cut or pierced with embowelling needles; they have been cauterised, they have been burnt with a lighted stick, while the creatures neither struggled nor shrunk from the irritation, nor ever gave the smallest sign of pain. Oil of vitriol has been poured upon each of the parts belonging to a joint, and a piece of caustic has been dropped into its cavity, but still no pain ensued; nay, some have been so bold, may I not say so vicious, as to repeat these experiments upon the human body. Without such cruel and inhuman practices, we do not want opportunities of knowing, that, in the human body also, the tendons and bursæ have no acute feeling. When we cut open a fascia or tendinous membrane, there is little pain: when (as in amputation) we cut the ragged tendons even and neat, there is no pain: when we snip with our scissars the ragged tendons of a bruised finger to cut it off, the patient does not feel: when we see tendons of suppurating fingers lying flat in their sheaths, we draw them out with our forceps, or touch them with probes, without exciting pain. In the old practice of sewing tendons, there was some danger, but no immediate pain: when we cut down into the cavity of a joint, still the pain is but slight. There is very little pain when the ligament of the patella is broken away from the tibia, nor when the great Achillis tendon is torn. There is but little pain in the moments of those accidents which appear slight in the time, but which turn out to be the most dreadful sprains. Yet, after rupture of the patella, the knee inflames and swells: after rupture of the Achillis tendon, there is swelling

and inflammation, with such adhesion of the parts as makes the patient lame; after the slightest sprain, such inflammation sometimes comes on as destroys the joint. There is but little pain when we first make an opening into any joint; yet it often brings on such pain and fever, that the patient dies. In short, every thing conspires to prove, that though in wounds of the less feeling parts, there is indeed future danger, there is no immediate pain. Still there are many accidents which prove to us, that even in health, the joints are not entirely exempted from pain: a smart stroke on the knuckles, or a blow on the elbow, or a fall upon the knee, are not perhaps the purest instances of feeling in joints: for such blow may have hurt some external nerve; but when a small moveable cartilage forms within the joint of the knee, though it be small and very smooth, and lodged fairly within the cavity of the joint, it often gets betwixt the bones, causing instant lameness; the moment it causes this lameness, it brings dreadful pains; the pain, the lameness, and all the feeling of inconveniency subside the instant that this cartilage is moved away from betwixt the bones; and the joint continues easy till this moving cartilage chances again to fall in betwixt the heads of the bones. Even the pain from a blow upon the knee, for example, is plainly within the joint, and is caused by the force with which the patella is struck down against the ends of the bones; what indeed is a sprain, but a general violence and twisting of all the parts which compose the joint? These parts are of one common nature, and may be arranged and enumerated thus: a joint is composed of the heads of the bones swelling out into a broader articulating surface, and of a thin plate of cartilage, which covers and defends the head of each bone; sometimes of small and moveable cartilages which roll upon the bones, and follow all the motions of the joint, and, like friction wheels in machines of human invention, abate the bad effects of motion. There is a secreting apparatus within every joint, which pours out a

lubricating fluid called synovia; and there is a bursal membrane reflected from the cartilages that tip the head of one bone to the edges of the cartilages of the opposite bone: this membrane confines the lubricating fluid, and serves at the same time to separate what is properly called the joint from the surrounding parts. This fine bursal or synovial membrane is surrounded and strengthened by a membrane of a more ligamentous character, which serves to bind the bones together. Sometimes this is called membrana capsularis, and sometimes more appropriately, LIGAMENTUM CAPSULARE: there are lesser ligaments on the outside of this, going along the sides of the joint, and passing from point to point: there are great tendons moving over the joint, and bursæ, or mucous bags, which accompany these tendons, and prevent the violence which their continual rubbing might do to the bones.

It is remarkable how slowly physiologists have come to the right knowledge of this matter. The fact is that all the apparatus of the joint is sensible cartilage, ligament, and tendon; but they do not possess the same kind or degree of sensibility with the skin and some other parts. They have just the degree and the kind of sensibility which is suited to their function; that is to say, which permits the performance of their office, yet gives us token of violence by pain. Their sensibility, like the sensibility of other parts, being obviously designed as a guard upon them that we may be careful of such accidents, and avoid such exertions, as would be injurious to their texture. Though seemingly insensible to the common modes of inflicting pain, yet are the ligaments and tendons and sheaths sensible to sprains and bruises, and such kind of injury as they are naturally exposed to. And when once the process of inflammation is set up in them, they become the seat of excruciating agony. The inflammation of joints, and of all the parts belonging to them, breaks up the organization of the part, evolves the feeling, and then in them also comes disease and violent pain. They are slow

in entering into action, but once excited, they continue to act with a perseverance quite unknown in any other part of the system. Their mode of action, whatever it may be at the time, is not easily changed: if at rest, they are not easily moved to action, and their excessive action once begun is not easily allayed. The diseases are infinite to which these parts are subject. They are subject to dropsical effusions; they are subject to gelatinous concretions; they are subject to slight inflammation, to suppuration, to erosions of their cartilages, and to exfoliation corresponding with the dropsies, suppurations, and mortifications of the softer and more feeling parts. Rheumatism is an inflammation round the joints, with a slighter effusion which is soon absorbed: chronic rheumatism is a tedious and slow inflammation, with gelatinous effusions round the tendons, and permanent swelling and lameness of the joints. Gout, in a joint, is a high inflammation, with a secretion of earthy matter into its cavity. The inflammation of tendons attends sprain: effusion of gelatinous matter round them forms ganglion: suppurations in the tendinous sheaths is whitlow: the inflammation of bursæ is false white swelling, not easily distinguished from the true: the disease of the joint itself is either a dropsy, where the joint, though emptied by the lancet, is filled up again in a few hours, showing how continual, and how profuse, both the exhalation and absorption of joints naturally are: or it is white swelling, which, next to consumption, is the most dreadful of all scrofulous diseases, which begins by inflammation in the joint itself, is marked by stiffness, weakness, loss of motion, and pain; which goes on through all the stages of high inflammation, dreadful pain, destruction of cartilages, suppurations and spontaneous openings of the joints; which sometimes stops by an effusion of callus and concretion of the bones, forming a stiff joint, but which oftener ends in hectic fever, diarrhœa, morning sweats, and extreme weakness; so that the patient dies, exhausted with fever and pain.

OF THE JOINTS.

Almost every thing relating to the heads and processes of the bones, and every proposition concerning the motions which they have to perform, has been already explained, anticipating much of the anatomy of the joints: and the principles of motion mentioned in describing the bones, shall form the chief propositions on which my descriptions of joints shall be arranged, seeking that method chiefly by which the joints may be easily and rapidly explained; for it is a subject on which volumes might be bestowed, and not in vain.

I should not wish the readers of this book to be ignorant of terms, which it is, however, bad taste to introduce into our discourse, as they are useless and pedantic, viz.

Diarthrosis is the free articulation, or proper joint.

When the globular head of a bone rolls in a socket, it is *Enarthrosis*.

When plain surfaces meet, as in the bones of the tarsus, we have the term *Arthrodia*.

The hinge joint is called *Ginglimus*.

When a bone turns by rotation it is termed *Trochoides*.

When there is a firm union by cartilage, admitting no motion, or very little, the term *Synchondrosis* is appropriate.

LIGAMENTS OF THE HEAD AND SPINE.

We may compare, in the following order, the chief motions of the head and trunk. The head is so placed upon the oblique surfaces of the atlas, that it cannot turn in circles; but at that joint all the nod-

ding motions are performed. The atlas rests so upon the vertebra dentata, that there all the turning motions are performed. The neck and loins have their vertebræ so loosely framed, with such perpendicular processes and easy joints, that there all the bending motions are performed, while the back is fixed, or almost fixed, by its connection with the ribs, and by the obliquity and length of its spines; and though, upon the whole, the spine turns many degrees, yet it is with a limited and elastic motion where the whole turning is great, but the movement of each individual bone is small.

To secure these motions, we find, the occipital condyles received into hollows of the atlas, where the oblique position of the condyles secures the joint, the occipital condyles looking outwards, the articulating surfaces of the atlas looking towards each other, the occiput set down betwixt them, so as to be secured towards either side, and the obliquity of the joint being such withal as to prevent the head from turning round. These joints of the occiput, with the atlas, are, like the greater joints of the body, secured with regular capsules, or bag-like ligaments, for each condyle, each rising from a rough surface on the vertebræ, and being fixed into a roughness at the root of the condyle. We find a flat membraneous ligament, which extends from the ring of the atlas to the ring of the occipital hole, closing the interstice betwixt the occiput and the atlas: it is confounded at the sides with the capsules of the articulating processes; is very strong before; and at the middle short point of the atlas it seems a distinct ligament*, which is strong only at this point, and very lax and membraneous behind.

We find the atlas tied to the dentata by a more complete order of ligaments. These are, 1st, (as betwixt the atlas and dentata,) regular capsules, or bags, fixing the condyles of one vertebra to the

* This is part of what Winslow called LIGAMENTUM INFUNDIBILIFORME, a FUNNEL-LIKE LIGAMENT, joining the first vertebræ to the occiput.

condyles of the other. 2dly, A cross ligament* which, crossing the ring of the first vertebra, makes a bridge, embraces the neck of the tooth-like process, and ties it down in its place. 3dly, A smooth and cartilaginous surface all round the root of the tooth-like process, where this tooth of the dentata turns in the ring of the atlas, and is bound by the ligament; and this rolling of the atlas upon the axis of the dentata is so fair and proper a joint, that it also is all included in a capsular ligament. 4thly, The point of the tooth-like process having threaded the ring of the atlas, almost touches the occipital hole; and there another ligament ties it by its point to the occipital hole.†

All the other vertebræ have another kind of articulation; to which the occiput, atlas, and dentata are the only exceptions, for their motions are particular, and quite different from the rest. The atlas and dentata bend, turn, and roll by connections resembling the common joints of the body; but the other vertebræ are united, each by its INTERVERTEBRAL SUBSTANCE, to the bones above and below; they are also united by their articulating processes to each other: each articulating process is held to another by a distinct capsule; each intervertebral substance is secured, bound down, and strengthened by strong ligaments; for the intervertebral substance, which of itself adheres very strongly to the periosteum, and to the rough socket-like surface upon the body of each vertebra, is further secured by a sort

* Viz. LIGAMENTUM TRANSVERSALE, or TRANSVERSUM; and what are called the APPENDICES of the TRANSVERSE LIGAMENT, are merely its edges, extending upwards and downwards, to be fixed into the dentata, and into the occipital hole, so as to enclose the tooth-like process of the dentata in a capsule.

† There are two flat ligaments which come from about the neck or root of the tooth like process, and which go obliquely upwards, to be fixed into the groove just behind the lip of the occipital hole; but the ligament from the point of the tooth-like process is not what it has been supposed, a fair round ligament of some strength; there is nothing more than a few straggling fibres of ligament going from the point to the occiput, though Eustachius has drawn it round and strong.

of cross ligaments, which go from the rim or edge of one vertebra to the edge of the next, over the intervertebral substance; and so, by adhering to the intervertebral substance, they strengthen it. These ligaments cross each other over the interstice betwixt each vertebra, and are very strong in the lumbar portion. They are regular and shining, and are named INTERVERTEBRAL CRUCIAL LIGAMENTS.

The spine is further secured by a general ligamentous or tendinous expansion, which goes over the fore parts of all the vertebræ, from top to bottom of the spine. It begins at the fore part of the atlas; it almost passes the body of the dentata, or is but very slightly attached to it. It is at first pointed, small, and round; it begins to expand upon the third vertebra of the neck, so as to cover almost all its body. It goes down along the bones, chiefly on their fore parts, and is but little observed on their sides. It is weaker in the neck, where there is much motion: stronger in the back, where there is none; weaker again in the loins, where the vertebræ move; but still on the bodies of all the vertebræ it is seen white, shining, and tendinous. We can distinguish all along the spine interruptions and fasciculi, or firmer bundles going from piece to piece of the spine; which fasciculi are indeed very seldom continued, without interruption, further than the length of two or three vertebræ; yet the whole is so much continued, that it is considered as one uninterrupted sheath, and is called the EXTERNAL OR ANTERIOR VAGINA, OR LIGAMENT of the SPINE.*

But still the canal of the spine were left open and undefended, rough and dangerous to the spinal marrow, if internal ligaments were not added to these. The rings of the vertebræ are held at a considerable distance from each other by the thickness of the

* The LIGAMENTUM COMMUNE ARTERIUS, FASCIA LONGITUDINALIS ANTERIOR, FASCIA LIGAMENTOSA, &c. It is from this ligament in the loins that the crura diaphragmatis arise with tendons flat and glistening like the ligament itself, and hardly to be distinguished from it.

intervertebral substance, and by the corresponding length of the oblique processes; but this space is filled up by a strong flat ligament of a yellow colour, which goes from the edge of one ring to the edge of another, and so extending from the articulating processes, backwards to the roots of the spinous processes, they fill up all the interstice, complete the canal of the spinal marrow, and bind the bones together with great strength*: these are assisted in their office of holding the vertebræ together, by a continuation of the same ligament, or of a ligamentous membrane connected with it, which runs all the way onwards to the ends of the spinous processes, where they are strengthened by accidental fasciculi†; and in the middle vertebræ of the back, but not of those of the loins or neck, similar ligaments are found also betwixt the transverse processes.‡

Next there is another internal ligament, which is not interrupted from bone to bone, but runs along all the length of the spine, within the medullary canal; and it corresponds so with the external vagina, or anterior ligament of the spine, that it is called the POSTERIOR OR INTERNAL ligament.§ It begins at the occiput, lies flat upon the back part of the bodies of the vertebræ; at the interstice of every vertebra it spreads out broad upon the intervertebral substance, doing the same office within that the intervertebral crucial ligaments do without. It is broader above; it grows gradually narrower towards the loins. Although it is called a vagina, or sheath, it does by no means surround nor enclose the spinal marrow, but is en-

* They are named the LIGAMENTA SUBFLAVA CRURUM PROCESSUUM SPINOSORUM.

† These are named the MEMBRANÆ INTERSPINALES, and LIGAMENTA APICIUM SPINOSORUM or FUNICULI LIGAMENTOSI. The ligaments which tie the points of the spines, running from point to point, make a long ligament which stretches down all the spine.

‡ Called LIGAMENTA PROCESSUUM TRANSVERSORUM, and found only from the fifth to the tenth vertebra of the back.

§ FASCIA LIGAMENTOSA POSTICA, FASCIA LONGITUDINALIS POSTICA, LIGAMENTUM COMMUNE POSTERIUS.

tirely confined to the covering of the bodies of the vertebræ, never going beyond the setting off of the articulating surfaces, or the place where the nerves go out. It adheres firmly to the bones, and does not belong at all to the spinal marrow. It should rather be called a ligament for the bones, than a sheath for the medulla. The anterior ligament prevents straining of the spine backwards; this one prevents the bending of the spine too much forwards; and they enclose betwixt them the bodies of the vertebræ, and their intervertebral substances.

There is yet a third internal ligament, which belongs entirely to the neck; it is called APPARATUS LIGAMENTOSUS COLLI: it begins from the edge of the occipital bone, descends into the canal of the vertebræ, is thin and flat, and adheres firmly to the body of each vertebra, covering the tooth-like process. The irregular fasciculi, or bundles of this ligament, stretch from bone to bone; and the whole of the apparatus ligamentosus extends from the edge of the occipital hole to the fourth vertebra of the neck, where it ends. Its chief use is also as a ligament, merely fixing the head to the neck. The dura mater is within it, immediately enclosing the spinal marrow. The ligaments which I have just named may be well enough allowed to be "at once ligaments for the bones, and a sheath for the medulla." But there is no such sheath as that called ligamentum infundibiliforme by Winslow; for either they are peculiar and distinct ligaments for the bones, such as I have described, or they belong exclusively to the medulla, as the dura mater, which is indeed strengthened at certain points into the thickness of a ligament; but the only close connection of the spinal marrow with the ligaments of the spine, is just at the hole of the occipital bone; and for a little way down through all the rest of the spine, the connection is by the loosest cellular substance.

OF THE LOWER JAW.

The LOWER JAW is, by its natural form, almost a strict hinge, and the lateral motion in grinding is but very slight. The joint is formed by a deep hollow or socket in the temporal bone; by a ridge which stands just before the proper socket, at the root of the zygomatic process; and by the long small head, or condyle, of the jaw, placed across the long branch, or condyloid process. These form the joint: and the condyle, the hollow of the temporal bone, and the root of the zygomatic process, are all covered with articulating cartilage. The joint is completed by a capsule of the common form, which arises from the neck of the condyle, and which is so fixed into the temporal bone as to include both the proper socket and the root of the zygomatic process. Thence it is manifest, that in the motions of the jaw, this transverse ridge is required as a part of its articulating surface; that the common and lesser motions are performed by the condyle moving in the deepest part of its socket; that the larger and wider openings of the mouth are performed by such depression of the jaw as makes its condyle mount upon the root of the zygomatic process. When there is luxation of the jaw there is a starting forwards of the condyle, till it is lodged quite before and under the zygomatic process; and the condyle standing upon the highest ridge, is the dangerous position in which luxation is most easily produced.

To render these motions very easy and free, a moveable cartilage is interposed. We find such cartilages in the joints of the clavicle, wrist, knee, and jaw, because the motions are continual and rapid. The moveable cartilage is thin in its centre, and thicker towards its edges, by which it rather deepens than fills up the hollow of the joint. It corresponds in shape with the head or condyle of the jaw, and with the hollow of the temporal bone. It moves with every motion of the jaw, facilitates the common motions, and prevents luxation. Its edges all round are

fixed down by ligaments, but the joint is still more strongly secured by lateral ligaments on the inside and outside, and by the strength of its pterygoid and temporal muscles, which are inserted close round the joint. It is the muscles which prevent luxation; and it is their action also that makes luxation, when it has happened, so difficult to reduce. We may mention here a ligament or strong band of fascia that passes from the styloid process to the angle of the jaw, and sends a slip downwards also to the body of the os hyoides, as it were to suspend it.

The Ligaments of the jaw are these:

1. Membrana Articularis.
2. Ligamentum Cartilaginis Intermediæ.
3. Ligamentum Maxillæ Laterale Internum.
4. Ligamentum Maxillæ Laterale Externum.
5. Ligamentum inter Maxillam et Processum Styloideum.

After these descriptions of the ligamentous connections of the spine the student may require some more precise table; for example:

LIGAMENTS OF THE VERTEBRAL COLUMN.

SEEN EXTERNALLY.

First, as standing by itself peculiar, the intervertebral substance.

1. Ligamenta Capsularia.
2. Ligamenta Crucialia ligamentorum intervertebralium.
3. Ligamentum Commune Anterius, or Fascia Longitudinalis Anterior.
4. Ligamenta Apicium Processuum Spinosorum, or Funiculi Ligamentosi.
5. Ligamentosæ Interspinales membranæ.
6. Ligamenta Processuum Transversorum.

LIGAMENTS SEEN ON MAKING THE SECTION OF THE SPINE.

1. Ligamentum Commune Posterius, or Fascia Longitudinalis Posterior.
2. Ligamenta subflava Crurum Processuum Spinosorum.

LIGAMENTS BETWIXT THE HEAD AND UPPER VERTEBRA.

1. Apparatus Ligamentosus.
2. Ligamentum Infundibiliforme.
3. Ligamenta Capsularia.

4. Ligamentum Perpendiculare.
5. Ligamentum Transversale — Appendices ejus.
6. Ligamenta Lateralia Moderatoria.

These ligaments of the spine, which strengthen and support bones of very delicate and spongy texture, are very subject to scrofulous inflammation.

The transverse ligament has been burst, and the tooth-like process of the second vertebra has crushed the spinal marrow, with instant death ensuing.

A diastasis, or partial separation of the vertebræ of the neck, with laceration of ligaments, is no unfrequent effect of falling from a height on soft ground.

A subluxation of the atlas from the vertebra dentata, has occurred from suddenly turning the head, and death has attended the attempts at reduction.

Subluxation of the lumbar vertebræ, that is displacement of the articulating processes, I have often seen.

Total dislocation of the bodies of the vertebræ is a very rare accident; yet there is an instance in my collection, where the child lived more than a year, and died at last of croup.

After all twists and injuries of the ligaments of the spine, although there may be no dislocation, we have reason to be apprehensive of inflammation of the ligaments or general sheath of the spinal marrow.

RIBS.

The ribs have two joints, and a hinge-like motion, rising and falling alternately, as we draw in or let out the breath. The two joints of the ribs are thus secured: First, the proper head of the ribs being hinged upon the intervertebral substance, and touching two vertebræ, it is tied to the bodies of each by a regular capsule; the bag is regular, is lubricated within, and is as perfect as any joint in the body;

it is radiated without, so as to expand pretty broad upon the sides of the vertebræ, and has a sort of division, as if into two fasciculi, the one belonging to the vertebra above, the other to the vertebra below: they gradually vanish, and mix with the periosteum upon the bodies of the vertebræ; these are named LIGAMENTA CAPITELLORUM COSTARUM, as belonging to the little heads of the ribs.

The back of the rib touches the fore part of the transverse process, and is articulated there: consequently there is a small capsular ligament belonging to this joint also; but this joint is further secured by two small ligaments, which come from the transverse process of the vertebra, and take hold on the neck of the rib: one short ligament coming from the point of the transverse process, is behind the rib, and thence named LIGAMENTUM TRANSVERSARIUM EXTERNUM; another, rather longer, comes from the inner face of the transverse process above, goes down, and a little round the neck of the rib is implanted into the edge of the rib, and is named LIGAMENTUM TRANSVERSARIUM INTERNUM: another small ligament exactly opposite to this, going from the outside of the transverse process into the neck of the rib, upon its back part, and crossing the last, is also very regular; it is called LIGAMENTUM CERVICIS COSTÆ EXTERNUM: and other subsidiary ligaments from different points assist these or supply their place.

The ribs are fixed into the sternum by their cartilages, each of which has a round head, a distinct socket, a regular capsule, and ligaments which expand and are scattered upon the surface of the sternum, much in the same way that the ligamenta capitelli expand upon the bodies of the vertebræ: a tendinous membrane also binds the cartilages of the ribs one to another, crosses over the interstices, and so covers the intercostal muscles with a sort of fascia; and the whole surface of the sternum and that of the cartilages is covered with this tendinous expansion, which belongs confusedly to the origins of the pec-

toral muscles, to the ligaments of the ribs and sternum, and to the periosteum of that bone.

LIGAMENTS BETWIXT THE RIB AND THE SPINE.

1. Ligamentum Capitelli Costæ Anterius.
2. Ligamenta Capsularia Capitelli.
3. Ligamentum Capsulare (of the union with the transverse process).
4. Ligamentum Externum Transversarium.
5. Ligamentum Transversarium Internum.
6. Ligamentum Cervicis Costæ Externum.

ANTERIOR EXTREMITY OF THE RIBS AND STERNUM.

1. Ligamenta Radiatim Disjecta.
2. Ligamenta Transversa.
3. Membrana Sternalis.

JOINTS OF THE SHOULDER, ARM, AND HAND.

CLAVICLE — STERNUM — SCAPULA.

THE joining of the clavicle with the sternum is the hinge upon which the whole arm moves, and is the only point by which the arm is connected with the trunk: the round button-like head of the clavicle rolls upon the articulating surface of the upper bone of the sternum: it is in such continual motion, that some particular provision is required; and accordingly it has, like the condyle of the jaw, a small moving cartilage, which rolls betwixt this head and the sternum. The cartilage is thin, and of a membraneous nature; it is moveable in some degree, yet it is fixed by its edges to the head of the clavicle and the socket of the sternum. This joint is enclosed in a strong capsule, consisting first of a bag, and then of an outer order of fibres, which go out in a radiated form upon the surface of the sternum, like the ligaments of the ribs; and they cross and cover the sternum, so that the ligaments of the opposite sides meet: and this meeting forms a cord

across the upper part of the sternum, which is named INTERCLAVICULAR LIGAMENT. Thus is the clavicle fixed to the sternum, and another broad ligament also ties it to the first rib, viz. the LIGAMENTUM RHOMBOIDES.

The joining of the clavicle with the scapula is by the edge of the flat clavicle, touching the edge of the acromion process with a narrow but flat articulating surface: both surfaces, viz. of the acromion and of the clavicle, are covered with a thin articulating cartilage: in some subjects a moveable cartilage is also found here: it is a regular joint, and is very seldom obliterated; yet its motion, though continual, is not very free; it is rather a shuffling and bending of the scapula upon this bone, favouring the play of the other joints: it is secured first by a capsular ligament, which is in itself delicate and thin, but which is strengthened by many ligamentous bands, which pass (over the capsule) betwixt the clavicle and the acromion process: the clavicle, as it passes over the point of the coracoid process, is tied down to it by ligaments of considerable strength; one comes from the root of the coracoid process to the clavicle, and is called LIGAMENTUM COMMUNE CONOIDES; another from the point of the coracoid process, is implanted into the lower or inner edge of the clavicle, and is named LIGAMENTUM COMMUNE TRAPEZOIDES—trapezoid, on account of its square form, and commune, because it goes from the scapula to the clavicle: while other ligaments, going from one process of the scapula to another, are named proper or peculiar ligaments of the scapula.

The LIGAMENTUM PROPRIUM TRIANGULARE stretches from the coracoid process to the acromion process of the scapula. The LIGAMENTUM SCAPULÆ PROPRIUM POSTERIUS is of less importance, being that which completes the notch of the scapula into a hole, and gives attachment to the omo-hyoideus muscle.

The acromion scapulæ is sometimes separated from the end of the clavicle, and the accident may be mistaken for a dislocation of the humerus.

The sternal extremity of the clavicle is sometimes dislocated. A case presents to me while this is going to press. It is an accident very easily distinguished, for the great tubercle on the end of the bone rises like a tumor, and the part of the mastoid muscle arising from it is also raised, and seems as if, by its contraction, it pulled up the bone.

SHOULDER-JOINT.

The SHOULDER is one of the most beautiful joints, loose and moveable, very free in its motions, but very liable to be displaced. To form this joint, the humerus has a large round and flattened head; the cavity of the scapula*, which receives this head, is oval, or triangular, small and very shallow; it is eked out with a thick cartilaginous border, which increases the hollow of the socket, but still it is so shallow, that the humerus cannot be so truly said to be lodged in the glenoid cavity as to be laid upon it. Its capsule or bag is very loose and wide, coming from the edges of the glenoid cavity, and implanted round the neck of the bone: the joint is richly bedewed with synovia, which is partly secreted by a fimbriated organ, the common organ for this secretion through all the joints, and by a thinner exudation from those extreme arteries which terminate, with open mouths, upon the internal surface of the capsule.

By the shallowness of its socket, and the largeness of its head, by the looseness of its capsule, by all the forms and circumstances of its structure, the shoulder is exceedingly loose, and very liable to be displaced: it has this loose structure, and superficial socket, that its motions may be free, but seldom is there any great advantage gained in the human body, without a counterbalance of weakness and danger; and every where in the limbs we observe that a joint is weak and liable to luxation in proportion as its motions

* It is called a glenoid cavity, from the Greek name of a joint, and the name is not absolutely appropriated to the scapula.

are free and large. Yet the shoulder-joint is not without some kind of defence; its socket is shallow, but it is guarded by the largest projecting processes in all the body, by the acromion projecting and strengthening it above, and by the coracoid process within; its ligament is lax, easily torn, and useful rather for confining the synovia, and keeping the head of the humerus opposite to its proper cavity, than in securing the joint by any strength it has: therefore a ligament extends from the coracoid to the acromion process, (LIGAMENTUM PROPRIUM TRIANGULARE SCAPULÆ,) which completes the defences of the joint above, and at its inner side. The capsule is perforated by the long tendon of the biceps muscle*, to arrive at which it takes a long course through a sheath which passes over the groove in the bone which lodges the tendon; and there comes also from the point of the acromion process an additional ligament, which adheres to the capsule: but the circumstance from which the chief strength of the shoulder-joint is derived, is the insertion of the four muscles which come from the scapula close round the head of the bone, so that they adhere to the capsular ligament, pull it up to prevent its being checked in the motions of the joint, strengthen it by their thickness, for they are spread upon it: and the contraction of the muscles holds the humerus in its place: their total relaxation (as in certain cases of weakness) suffers the humerus to drop away from the scapula, without any fall or accident, forming what we are accustomed to call a luxation of the humerus, from an internal cause; and the shoulder cannot be luxated by a fall, without such violence as tears up the tendons of these muscles. We must add to this anatomy of the joint, that it is surrounded by numbers of bursæ or mucous bags: one under the tendon of the subscapularis; one under the short head of the biceps muscle; one betwixt the coracoid process and the shoulder-bone; and one

* The capsular membrane is perforated, while the thin synovial membrane is reflected upon the tendon.

under the acromion process of the scapula, exceedingly large: and these are so fairly parts of the joint, that very commonly they open into it with communications, either perfectly natural, or at least not hurtful, either originally existing, or formed by continual friction. It should also be remembered, that the long tendinous head of the biceps muscle comes from the margin of the socket, directly over the ball of the os humeri, and through the capsule, and answers the purpose of a ligament.

RECAPITULATION OF THE LIGAMENTS ABOUT THE SHOULDER.

(Between the clavicle, sternum, and first rib).

1. Membrana Capsularis.
2. Cohæsio Fibrarum Externa.
3. Connectio Cartilaginis Interarticularis.
4. Ligamentum Interclaviculare.
5. Ligamentum Rhomboides [betwixt clavicle and rib.]

(Between the clavicle and scapula).

1. Ligamentum Capsulare.
2. Ligamenta Radiata [on the point of the acromion].
3. Ligamentum Commune Trapezoides.
4. Ligamentum Commune Conoides.

(Ligaments proper to the scapula).

1. Ligamentum Proprium Triangulare, seu Deltoides.
2. Ligamentum Proprium Posterius.

(Ligaments of the shoulder joint).

1. Membrana Capsularis [strengthened by the tendons of muscles].

The most frequent dislocation is that of the humerus from the glenoid cavity of the scapula.

ELBOW.

The ELBOW-JOINT is formed by three bones; the humerus, radius, and ulna: the ulna bends backwards and forwards upon the shoulder-bone; the radius bends upon the shoulder-bone along with the ulna; it always must accompany the ulna, but it also has a motion of its own, rolling in circles; its

round button-like head rolling continually with its edge upon a socket in the ulna, and with its flat face upon the tubercle of the humerus. The whole composes one joint, and is enclosed in one capsule; the bones accompany each other in their luxations, as well as in their natural motions; the ulna is never dislocated without the radius being also displaced; a circumstance which is but too little noticed, and, so far as I remember, hardly considered or known.

The radius and ulna are united principally by the INTEROSSEOUS LIGAMENT, which, as it extends in the whole length of the bones, has great strength. Towards the elbow this ligament is deficient for a space, and it is perforated by vessels. The CHORDA TRANSVERSALIS CUBITI is an oblique slip of ligament which passes from the tubercle of the ulna obliquely downwards and across to the tubercle of the radius.

LIGAMENTS OF THE ELBOW-JOINT.

The general CAPSULE arises from the humerus, from both the tubercles, and all round the two hollows which receive the olecranon and coronoid processes of the ulna; it is implanted again into the tip of the olecranon, and all round that sigmoid cavity of the ulna which receives the lower end of the humerus, and all round the edge of the coronary process. It is also fixed round the neck of the radius; it comprehends, in one bag, the humerus, radius, and ulna; and unites them into one joint, performing two motions, viz. flexion and extension by the ulna, and rolling by the radius; the joint is lubricated and protected by synovia and by fat*, which is found chiefly about the olecranon: and that the bones may be further secured, additional ligaments are spread out upon them, which are all without the common capsule of the joint, lying upon it, and strengthening it at the necessary points.

1. There is the common capsule enclosing the whole. 2. It is the form of every hinge-joint (and

* The oil contained in the adipose membrane never exudes in the living body, and cannot lubricate.

this is one of the purest) to have its capsule strengthened at the sides; and the sides of this, the elbow-joint, are strengthened by two fasciculi, or ligamentous bands, which, coming from the tubercles of the humerus, spread a little upon the capsule, and adhere to it like part of its substance. One, from the outer condyle, spreads upon the neck of the radius, and sends a strong division to be attached to the rough spine of the ulna, which is near the lesser sigmoid cavity of the ulna. This is of course the EXTERNAL LATERAL LIGAMENT. Another ligament, from the inner condyle of the humerus, goes upon the inside of the capsule and strengthens it there: it is implanted in the prominence on the inner edge of the coronoid process of the ulna, and is named the INTERNAL LATERAL LIGAMENT.* The continual rolling motion of the radius requires a peculiar ligament, and this peculiar ligament of the radius is named LIGAMENTUM CORONARIUM or ANNULARE, because it encircles the neck of the radius; ANNULARE or ORBICULARE, from its hoop or ring-like form; it is a very strong and narrow stripe or band, which arises from that part of the ulna where the radius rolls upon it, and surrounds the radius, making at least two thirds of a circle; and so, having turned over the neck of the radius, is inserted into the opposite side of the ulna. This is commonly described as a distinct ligament surrounding the neck of the radius, and having the common capsule implanted into its upper edge; but, in truth, it is like the others, a thicker band of the common capsule, but with a distinction much more particular here by the contrast of the great thickness of the coronary ligament, and the extreme thinness of the capsule at the fore part: for the capsule of

* I see another ligament behind the internal lateral ligament, viz. arising from the internal condyle, and inserted into the side of the olecranon. There are in truth two internal lateral ligaments, and their operation is not merely to confine the motion of the joint laterally, but to check the flexion and extension of the arm; the one being made tense by the flexion, the other by the extension of the fore-arm.

every hinge-joint is strong only at its sides; other bands from the outer condyle, and from the coronary process of the ulna, strengthen this ligament of the radius, and are known by the general name of ACCESSORY LIGAMENTS of the coronoid ligament, as the lateral ones are known by the name of ACCESSORY LIGAMENTS to the capsule.*

RECAPITULATION.

1. Membrana Capsularis.
2. Ligamentum Laterale Internum.
3. Ligamentum Laterale Externum.
4. Ligamentum Orbiculare.
5. Ligamenta Accessoria.

The ulna is sometimes dislocated from the trochlea of the humerus. The head of the radius may be separated from the lesser sigmoid cavity of the ulna. But this part of the ligamentous apparatus of the joint is more apt to be sprained, to swell, and thence be mistaken for dislocation of the head of the radius.

WRIST.

The WRIST is one of the most moveable joints in the body, having the strength of a mere hinge-joint; (because it is almost a strict hinge, by the connection of the long ball of the carpus with the long hollow of the radius,) and having, at the same time, all the properties of the most moveable joint by the free turning of the radius, without the weakness which is peculiar to the circular and free moving joints. These distinctions divide the wrist-joint into its two parts.

1. The articulation formed by the scaphoid and lunated bones, which form an oval ball of articulation, and the great scaphoid cavity of the radius which re-

* But the capsule ought to be called membrana capsularis; it is not a ligament, and these which are called accessory are proper ligaments. The ligament which is on the fore part of the joint, and which runs towards the *Ligamentum Annulare* is properly called *Accessorium Annuli Anticum*; it crosses from the ulna to the external condyle; and another coming round from the olecranon, and being on the back of the joint, *Accessorium Annulare Posticum*.

ceives this ball: the end of the ulna does not properly enter into the cavity of the wrist, but its end, or little round head, is covered with a moveable cartilage, and that cartilage represents the end of the ulna. It is called CARTILAGO INTERMEDIA TRIANGULARIS. Now, this first joint, viz. of the scaphoid and lunated bones, the head of the radius, and the moveable cartilage which represents the head of the ulna, are surrounded by the general capsule or bag of the joint. The CAPSULE arises from the ends of the radius and of the ulna; from the styloid point of the one, round to the same point of the other; and is implanted near the lower rank of the carpal bones; though it adheres first to the scaphoid and lunated bones, it passes them going over all the bones of the carpus, especially in the palm, so as to add strength to their peculiar ligaments; and in the palm, the tendons for the fingers run over it: so it forms on one side an additional ligament for the carpus; on the other, it forms the floor of the tendinous sheath, a smooth and lubricated surface for the tendons to run upon. This general ligament is strengthened by particular ones coming from the styloid processes of the radius and of the ulna, which spread upon the bones of the carpus, and may be described as LATERAL ligaments; for although the wrist-joint is not accurately a hinge, yet it partakes most of that character, and the ligaments are strongest at the radial and ulnar edges of the wrist. But there are so many irregular points of bone about the wrist, that the little fasciculi, with which this capsule is covered and strengthened, are innumerable. Within this joint, and stretching from the groove betwixt the scaphoid and lunated bones, there is an internal ligament of a soft and pulpy nature; it is named LIGAMENTUM MUCOSUM; but the very name shows, that it is less valuable as a ligament, (since the joint is already well enough secured,) than as a conductor for the lacunæ or ducts which secrete the synovia.

2. The articulation by which the hand performs all its turning motions is that of the radius with the ulna:

tais is set apart altogether from the general articulation of the joint. The lateral cavity of the radius receives the little round head of the ulna; they are enclosed in their own peculiar capsule, which is so loose about the bones, that although it is a regular capsule of the common form, it has the name of MEMBRANA CAPSULARIS SACCIFORMIS. Thus there is one joint within another; a moveable cartilage betwixt them, and the capsule of the one, the more moveable joint, peculiarly wide, and not so strong; all which should be considered in thinking about luxations of the wrist.

The carpal bones are connected with each other so very closely, that the name of joint can hardly be used. They are rather fixed than jointed together. Each bone has four smooth articulating surfaces, by which it is united to the adjoining bones. The first two bones form the great ball of the wrist; the second row again is united with the first, by a sort of ball and socket; for the os magnum, which is the central bone of the second row, has a large round head, which is received into the lunated hollow of the os lunare, which is the central bone of the first row. The first row is thus united to the second, by a distinct and general capsule, in addition to which each single bone is tied to the next adjoining, by a regular capsular ligament within, and by flat cross ligaments without, or rather by many bundles of ligaments, which cross each other in a very complicated manner, and the little flat and shining fasciculi give the whole a radiated or star-like form.* But there is a very particular ligament which descends from the styloid process of the ulna to the carpus, the use of which will be understood, if we rest upon our hands, for then the whole weight of the body is sustained by it.

* These are the ligaments which are really so unimportant to the anatomist, or to the surgeon, but which are so laboriously described under the titles of LIGAMENTA, BREVIA, OBLIQUA, TRANSVERSARIA, and PROPRIA ossium carpi; for they do in fact cross and transverse the carpus in every possible direction.

The metacarpal bones are also joined to the carpal in one row, by a line of joints, which are as one joint: besides their common capsule, the metacarpal of each finger has its peculiar ligaments proceeding in a radiated or star-like form from the carpal bones, and going out broad upon the metacarpal bones, and so numerous, that each metacarpal bone is securely tied by ligaments to one or two of the bones of the carpus *; and at their heads, where the fingers are implanted upon them, forming the knuckles, they are again tied by flat ligaments, which go from head to head of the metacarpal bones †, binding them together, permitting a slight bending towards each other, so as to make a hollow in the hand, but no such wide motion as might assist the fingers; they are but as a foundation upon which the fingers stand and move.

RECAPITULATION.

1. Funiculus Ligamentosus Ulnæ.
2. Membrana Capsularis.
3. Membrana Sacciformis.
4. Ligamentum Mucosum.
5. Ligamentum Cartilaginis Intermediæ.
6. Ligamentum Transversale Carpi Proprium.
7. Ligamentum Commune Carpi Dorsale.
8. Ligamentum Rhomboides.
9. Ligamenta Brevia.

FINGERS.

The joints of the fingers are formed by round heads in the upper end of one row of bones, and by hollow sockets on the lower ends of the next row; each joint is qualified, by the round form of its head, to be a circular and free moving joint; but it is restricted, by the forms of its ligaments, to the nature of a hinge-joint; for each finger-joint is included first in a fair round capsule, or bag, of the ordinary form, but

* And these also are named according to their several directions, LIGAMENTA ARTICULARIA, LATERALIA, RECTA, PERPENDICULARIA, &c.

† These are named the LIGAMENTA INTEROSSEA.

that capsule is strengthened by very distinct lateral ligaments upon its sides, which lateral ligaments form the chief strength of the joints; above these lateral ligaments the joint is strengthened by a broad fascia, or sheath, which comes from the tendons of the interossei muscles, covers the backs of all the fingers, which is especially strong over the joints. One part of the apparatus of the wrist-joint is the smooth and lubricated SHEATH, in which the tendons of the fingers run. It is formed in part by the outer side of the capsule of the wrist, and in part by that bridge of ligament which proceeds from the four corner points of the carpal bones. This sheath is lined with a delicate and softer modification of the common tendinous membrane, is fully bedewed with mucus, and is fairly to be ranked with the bursæ mucosæ, as it is indeed, like them, a shut sac. But it is farther crossed in such a manner by partitions belonging to each flexor tendon, that each of them may be said to have its appropriated bursa mucosa. And these bursæ, to prevent the bad consequences of friction, are put both betwixt the cross ligament and the tendons, and also betwixt the tendons of the uppermost muscle and of the deeper one, and again betwixt the tendons of the fingers and of the thumb.

In the same way the sheaths of the tendons, as they run along the fingers, may be considered as part of the apparatus of their joints; for the first set of bursæ, viz. those which lie in the palm of the hand, stop before they reach the first joints of the fingers, and then other longitudinal bursæ begin from the first joint of the fingers, and go all along them to the last joint, forming a sheath for the tendons to run in, which does at once the office of a strong ligament, binding them down in their places, and which is so lubricated on its internal surface, as to save the necessity of other bursæ. These sheaths are thicker in certain points, so as to form cross rings of strong ligament; but the common sheath, and these thicker rings, still form one continued canal; these are named the SHEATHS and

ANNULAR LIGAMENTS, or CROSS LIGAMENTS* of the fingers, and are of the same nature with the bursæ. Besides these, there are no distinct bursæ on the fingers, but there is one of considerable size at the root of the thumb.†

JOINTS OF THE PELVIS, THIGH, LEG, AND ANCLE.

OF THE PELVIS.

The ligaments of the pelvis may be divided into three distinct sets:—1st, those which unite the vertebræ and the sacrum: 2d, those which pass from the os ilium to the vertebræ: and 3d, those which are between the ilium and the sacrum. The ligaments which are at the upper part are of trifling importance, compared with those which form the outlet of the pelvis.

The ligaments connecting the last lumbar vertebræ to the sacrum are similar to those of the spine; so we need not describe them here.

The ilium is held in connection with the vertebræ, by two principal ligaments. The one passes from the crest of the ilium to the transverse process and body of the last lumbar vertebra, and is called LIGAMENTUM ANTICUM SUPERIUS. This ligament is often of a triangular form, owing to a small portion of it being prolonged up to the transverse process of the fourth vertebra. The other passes from the same point of the os ilium to the junction of the last vertebra with the os sacrum, and it is named LIGAMENTUM ANTICUM INFERIUS.

The principal bond of union between the os ilium and the sacrum is at the sacro iliac symphysis. The

* LIGAMENTA VAGINALIA, LIGAMENTA CRUCIATA, PHALANGUM, &c.

† Vide Monro's Bursæ Mucosæ.

scabrous surfaces of these two bones are joined by means of a ligamentous and cartilaginous substance, called the SACRO ILIAC LIGAMENT; it holds them firmly together, and allows of no motion between them. On the fore and back part there are accessory strengthening bands: those on the back part have been called generally LIGAMENTA DORSALIA VAGA; yet some have chosen to describe them separately, with the additional terms, longum, breve, laterale, annexed to them.

The LIGAMENTUM SACRO-ISCHIATICUM MAJUS OF POSTERIUS arises from the posterior part of the crest of the ilium, and from the sides and posterior part of the sacrum and os coccygis, and is attached to the tuberosity of the ischium. A portion of this ligament runs up towards the superior posterior spinous process of the ilium, and is called the superior appendix: but another more important portion, having connection with the fasciæ of the perineum, can be traced along the inside of the tuberosity of the ischium to the ramus of the os pubes: this is called the PRODUCTIO FALCIFORMIS OF WINSLOW. The LIGAMENTUM SACRO-ISCHIATICUM MINUS OF ANTERIUS crosses the last; it arises from the os sacrum and os coccygis, and is inserted into the spinous process of the ischium. The tendon of the obturator internus muscle passes through the opening left between these two ligaments.

The os coccygis is united to the sacrum by ligaments resembling those of the spine, or by the continuations of those lying on the back of the sacrum: the LIGAMENTA LONGITUDINALIA.

The bones of the pubes are united by an intermediate cartilage, which has great strength, and has a considerable resemblance in its structure to the intervertebral substance which joins the bodies of the vertebræ together. This junction has the name of SYMPHYSIS OF SYNCHONDROSIS OSSIUM PUBIS; and it is strengthened by a ligament which embraces it all round, and is called ANNULUS LIGAMENTOSUS. The connection of the ossa pubis is farther strengthened

by the TRIANGULAR LIGAMENT, which passes across from the ramus of each bone, and to which the urethra is suspended. The obturator foramen is closed by the MEMBRANA OBTURANS, except a small portion at its upper part, through which the obturator artery and nerve pass.

OF THE HIP-JOINT.

The acetabulum, which is rough in the naked bone, is naturally lined with a thick and very smooth cartilage. The head of the thigh-bone is covered with a similar cartilage, also very thick and smooth; and these cartilages almost fill up that deep dimple which is seen in the centre of the head of the thigh-bone, and smooth that hole which is formed in the centre of the socket, by the meeting of the several pieces of which it is composed. The socket is not only deep in its bones, but is further deepened by the cartilage which tips the edge of the socket, and which stands up to a considerable height. The socket is imperfect at that side which looks towards the thyroid hole; the bony edge is entirely wanting there, and the space is filled up by a strong cartilaginous ligament, which goes across this gap, from the one point to the other, and from its going across is named the LIGAMENTUM LABRI CARTILAGINEI TRANSVERSALE.* The capsular ligament of the hip-joint is the thickest and strongest of all the body. It is, like other capsules, a reflection and thickening of the periosteum; the periosteum coming along the outside of the bone, leaves it at the edge of the socket. The periosteum, or rather perichondrium from the inside of the socket, comes up to the edge, and meets the outer layer. They unite together, so as to form the general capsule enclosing the ring-like cartilage, which tips the edge of the socket between them.

* This ligament is double, that is, there is one on the inside of the edge, and one on the outside; thence it is often reckoned as two ligaments, viz. LIGAMENTUM TRANSVERSALE INTERNUM et EXTERNUM.

This ligament encloses all the bones from the edges of the socket to the roots of the trochanters, embracing not only the head, but the neck of the thigh-bone. The outer-plate, continuous with the periosteum, is thick and strong, and is assisted by much cellular substance condensed round it, and it is further thickened by slips which come from the iliacus, rectus, and other muscles which pass over the joint, while the external plate of the ligament lines the whole with a soft and well lubricated coat.

In addition to this general capsule, there are two internal ligaments, 1st, the round ligament, as it is called, which comes from the centre of the socket to be fixed into the centre of the ball of the thigh-bone. It is not round, but flat or triangular. It has a broad triangular basis, rooted in the socket exactly at that place where the several bones of the socket meet, forming a triangular ridge, which gives this triangular form to the central ligament. It has three angles, and three flat sides. It is broad where it arises from the bottom of the socket, is about an inch and a half in length, grows narrower as it goes outwards towards the head of the bone, and is almost round where it is implanted into the dimple in the head of the thigh-bone, at which point it is so fixed as to leave a very remarkable roughness in the naked bone. But round the roots of this ligament, and in the bottom of the socket, there is left a pretty deep hollow, which is said to be filled up with the synovial gland. It is wonderful how easily authors talk of the synovial gland, as if they had seen it; they describe very formally its affections and diseases, as when hurt by a blow upon the trochanter; yet there is no distinct gland to be found. There is a fringed and ragged mass lodged in the bottom of the socket, hanging out into the hollow, and continually rubbed by the ball of the thigh-bone in its motions: the fringes and points certainly are ducts from which we can squeeze out synovia; but it is by no means proved that they belong to a synovial gland, and it looks rather as if the ducts were them-

selves the secreting organ, like the lacunæ, or mucous bags in the tongue, or in the urethra, vagina, œsophagus, and other hollow tubes. Such a structure is fitter for suffering the strong pressure and continual action of the thigh-bone, than any determined gland. We see, then, nothing but mucous-like ducts of a fringed form, hanging down from this hollow in the cavity of the joint, a quantity of fat accompanying these fringes, and a pappy synovial membrane, which keeps these fringes and fatty membranes orderly and in their places, and which ties them so to the angles of the triangular ligament, that they must move with the motions of the joint. This mucous membrane, which keeps these fatty fringes orderly, has two or three small bridles in different directions, whence they are named the LIGAMENTA MUCOSA, or ligamentula massæ adiposæ glandulosa; and this may be considered as the continued inflection of the softer internal lamella of the capsule, which not only lines the socket, but is reflected over the central ligament, and over the globe of the thigh-bone, covering them also with a delicate synovial coat. Other fringes of the same kind are found at the lower part of the joint, lying round the neck of the thigh-bone, near the angle where the capsular ligament is implanted into the root of the great trochanter: the liquor from these fimbriæ, with the general serous exudations, are mixed and blended for lubricating the joint.

This capsule, which is naturally the thickest and strongest in the body, almost a quarter of an inch in thickness, is further strengthened by many additions; for a slip of very strong tendinous or ligamentous substance condensed, comes down from the lower spinous process of the os ilium, and spreads out over the capsule, and strengthens it very much on its fore part; the smallest of the glutæi muscles adheres to the capsule, and strengthens it behind; the psoas magnus and iliacus internus pass by the inner side of the capsule, and though they do not absolutely adhere to it, they deposit much cellular substance,

which is condensed so as to strengthen the capsule, forming at the same time a large bursa mucosa, betwixt their tendinous fibres and the joint. That tendon of the rectus muscle which comes from the margin of the socket, lies upon the outer side of the capsule, adheres to it, and strengthens it. The security of the hip-joint seems to depend more upon the strength of its capsular ligament, than that of almost any other joint.

RECAPITULATION OF THESE LIGAMENTS.

1. Ligamentum Capsulare.
2. Ligamentum Accessorium Anticum.
3. Ligamentum Teres.
4. Ligamenta Labri Cartilaginei.
5. Ligamentula Massæ Adiposæ.

The head of the thigh-bone is subject to dislocation upward and outward, and also to displacement downward and forward.

THE KNEE-JOINT.

The knee-joint is one of the most superficial joints, and one of the weakest so far as relates to the bones, for the flat condyles of the thigh-bone are merely laid upon the flat head of the tibia. There is here no fair cavity, receiving a large head, as in the joint of the hip; no slighter ball and socket, as in the fingers; no strong over-hanging bones, as in the shoulder; no hook-like process, as in the ulna. This is not a hinge-joint, like the ancle, secured between two points of bone. We do not find the means of strength in its bones, but in the number, size, and disposition of the great ligaments with which its bones are joined; by virtue of these ligaments it is the strongest joint of the human body, the most oppressed by great loads, the most exercised in continual motions, yet less frequently displaced than any other. But this complication of ligaments, which gives it mechanical strength, is the very cause of its constitutional weakness, makes it very delicate, and very liable to disease.

The bones which compose this joint are the tibia, thigh-bone, and patella; and they are united by many ligaments, both within and without the joint.

1. The CAPSULE of the KNEE is naturally thin and delicate. This thin capsule comes from the fore part of the thigh-bone, all round the articulating surfaces, whence it goes downwards by the sides of the condyles: from this origin it is inserted into all the edge of the rotula, and in such a way as to keep the rotula properly without the cavity of the joint, the synovial membrane going over its inner surface, and lining it with a smooth and delicate coat. It is fixed below into all the circle of the head of the tibia, and thus completes its circle, embracing all the bones. This capsule, naturally so thin and delicate, is made up from all the surrounding parts to a considerable thickness; first, it is covered behind by the heads of the gastrocnemii; at the sides, by the biceps, and other muscles of the hamstrings; on its fore part, it is strengthened by the general fascia of the thigh, which goes down over the knee, and being there reinforced both by its adhesion to the bones, and by the broad expansion of the vastus internus, sartorius, biceps, and other muscles which go out over the patella, it adheres to the capsule, and makes the whole very strong; besides which, there is a ligament, which, lying in the ham, upon the back part of the capsule, is named, in compliment to Winslow, LIGAMENTUM POSTICUM WINSLOWII. It is a ligament somewhat resembling the lateral ligaments of the elbow. It arises from the outer condyle, goes obliquely across the back part of the joint, adheres to it, and strengthens it; but often it is not found at all, or in such straggling fibres as cannot be accounted a ligament.* It is manifest that the knee requires some such additional ligaments behind, to serve as a check, and to prevent its yielding too far.

2. The knee, as being a hinge-joint, has strong ligaments at the sides, and here the lateral ligaments

* Often it is irregular, or in straggling fibres; but I have never found it wanting.

are particularly distinct, and can be raised from the capsule; on the inner side of the joint, there comes down from the internal condyle of the thigh-bone, a broad flat ligament, which is fixed into the inner head of the tibia, and is named the internal lateral ligament; on the outside of the knee, there descends from the tip of the outer condyle a much stronger ligament, not quite so flat, rather round: it extends from the condyle of the thigh-bone to the bump of the fibula which it embraces. It is a little conical from above downwards; it is from two to three inches in length, and is named LIGAMENTUM LATERALE EXTERNUM LONGIUS, to distinguish it from the next; for behind this first external ligament, there arises a little lower from the same condyle, along the outer head of the gastrocnemius muscle, a ligament which is called the LIGAMENTUM LATERALE EXTERNUM BREVIUS, and it is not shorter only, but so spare as not to be easily distinguished, not having the true form of a lateral ligament coming down from the condyle, but of a mere strengthening of the capsule, coming upwards from the knob of the fibula.*

3. The joint is still further secured by internal ligaments which are within the cavity of the joint; they are named the CRUCIAL LIGAMENTS of the knee. They arise betwixt the hollow of the condyles of the thigh-bone, and are implanted into the back part of the middle rising of the tibia: they lie in the back part of the joint, flat upon the back of the capsule, and the one crossing a little before the other (but yet in contact with each other, at the place of crossing); they are distinguished by the names of ANTERIOR and POSTERIOR CRUCIAL LIGAMENTS.

The POSTERIOR CRUCIAL ligament is more perpendicular; it arises from the hollow betwixt the condyles of the thigh-bone, and is implanted into a roughness on the back of the tibia, betwixt its two cup-like hollows, and behind the tubercle which

* Some strong, but irregular accessory ligaments go down to that part of the head of the tibia which is before the head of the fibula.

divides these hollows from each other. While the posterior arises rather from the internal condyle, the ANTERIOR LIGAMENT arises properly from the external condyle, passes obliquely over the tuber, in the articulating surface of the tibia, and terminates in the cup-like hollow. The effect of these two ligaments is more particular than is commonly observed; for the one goes obliquely out over the articulating surface of the tibia, while the other goes directly down behind the joint; and of course when the knee is bended, the anterior ligament is extended; when the leg is stretched out, the posterior ligament is extended; they both are checks upon the motions of the joint: the posterior ligament prevents the leg going too far forwards, the anterior ligament prevents it being too much bent back upon the thigh.*

4. The most admirable part of the mechanism of this joint, is the two SEMILUNAR CARTILAGES. They are so named from their semilunar form; they lie upon the top of the tibia so as to fill up each of them one of the hollows on the top of that bone. They are thicker towards their convex edges, thinner towards their concave edges; they end by two very acute and long horns, named the CORNUA of the lunated cartilages. In short, they resemble the shape of the label which we put round a wine decanter; and the two horns are tied to the tubercle, or ridge that stands in the middle of the articular surface of the tibia, and consequently they are turned towards each other, so as to touch in their points. There are here, as in the other joints, masses of fat enclosing the fimbriated ends of the mucous ducts. These fimbriæ, and fatty bundles, are formed chiefly round

* There is not attention enough paid to the origins of these ligaments from the femur; for it is the origin from the thigh-bone which determines their operation. The posterior ligament comes from the root of the internal condyle, and depth of the semilunar notch, anterior to the centre of motion of the femur on the tibia; it is consequently stretched in extending the leg. The anterior ligament arises from the root of the external condyle, posterior to the centre of motion; it is consequently stretched in the flexion of the knee-joint.

the circumference of the patella, commonly surrounding it with a complete fringe; they are also found at the back of the cavity, about the crucial ligaments, and in all the interstices of the joint, the fatty bundles filling up the interstices; there is one principal bed of this fatty matter at the lower part of the patella and around the commencement of its ligament.

These masses of fat lie covered by the delicate internal surface of the capsule, and the mucous fimbriæ are also covered by it.

The inner surface of the capsule is so much larger than the joint which it lines, that it makes many folds or lurks, and several of these are distinguished by particular names. Thus, at each side of the patella there are two such folds, the one larger than the other, whence they are named LIGAMENTUM ALARE MAJUS, and LIGAMENTUM ALARE MINUS. These two folds are like two legs, which join and form one middle fold, which runs across in the very centre of the joint, viz. from the lower end of the patella to the point of the thigh-bone, in the middle betwixt the condyles. It keeps the looser fatty bundles and fimbriated ducts in their place (viz. the hollow betwixt the condyles, where they are least exposed to harm); thence it has been long named the LIGAMENTUM MUCOSUM. The internal membrane of the joint covers also the semilunar ligaments, as a perichondrium; it comes off from the ridge of the tibia, touches the horns of the semilunar cartilages, moves over the cartilage, so as to give them their coat, and at the point where it first touches the horns, it forms four little ligaments, two for the horns of each cartilage. These tags by which the four points of the lunated cartilages are tied, are named the LIGAMENTA CARTILAGINUM LUNATARUM, or more simply named the four adhesions of the lunated cartilages. There is a little slip of ligament, which goes round upon the fore part of the knob of the tibia, and ties the fore parts of these two cartilages to each other. It is named LIGAMENTUM TRANSVERSALE COMMUNE, be-

cause it goes across from the fore edge of the one cartilage to the fore edge of the other, and because it belongs equally to each; but for their further security, these cartilages also adhere to their outer circle, or thick edge, to the internal surface of the general capsule of the joint by the LIGAMENTUM CORONARIUM, and that again adheres to the lateral ligaments which are without it; so that there is every security for these cartilages being firm enough in their places to bear the motions of the joint, and yet loose enough to follow them easily.

This joint has the largest bursæ mucosæ of all, and these perhaps the most frequently diseased. There is one bursa above the patella, betwixt the common tendon of the extensor muscles and the fore part of the thigh-bone, which is no less than three inches in length. There is a smaller bursa about an inch below the patella, and under the ligament of the patella, protecting it from friction, upon the head of the tibia. These bursæ, I am persuaded, are often the seat of disease, when it is judged to be in the joint itself. But the truth is very easily known; for if a swelling appear under the patella, projecting at the sides, and raising the patella from the other bones, we are sure that it must be in the main cavity of the joint: but if swellings appear above and below the patella, then there is reason to believe that these belong to the great bursæ, which are placed above and below the patella, a complaint which is far less formidable than a swelling of the joint itself: I would almost say, easily cured; for openings into these bursæ, though they should be avoided, are less dangerous than openings into the joint. It is from mistaking such tumours for collections in the capsule itself, that authors speak of openings into the joint as a familiar or easy thing, or think that they have done such operations safely, when probably they were puncturing the bursæ only.*

* I believe that the great bursæ and the joint always communicate largely; and that being consequently one continuous surface, the opening of the bursæ would be highly improper.—C.B.

These bursæ mucosæ lie under the tendon of the extensor muscles, and under the ligament of the patella: they are of the same substance with the capsule of the joint itself; they lie over the capsule, united to it by cellular substance; and the bundles of fat which are disposed irregularly about the joint belong partly to the bursæ and partly to the capsule; one end projecting into the cavity of the bursæ, while the other end of the same fatty bundles projects into the cavity of the joint.

Thus the knee-joint, which is the most important in all the body; the most oppressed by the weight of the trunk, and by the accidental loads which we carry; the most exercised in the common motions of the body, and the most liable to shocks and blows; which is the most superficial and the weakest in all that respects its bones, is the strongest in its ligaments, and the most perfect in all the provisions for easy motion.

1. The great CAPSULE of the joint encloses the heads of the bone; its synovial membrane secretes and contains the synovia; lines the joint with a smooth and delicate membrane, and, by turning over all the parts, and adhering to them, it forms the perichondrium for the cartilaginous heads of the bones, and the covering for the moving cartilages of the joint.

2. This capsule, which is exquisitely thin, and which was formed for other uses than for giving strength to the joint, is surrounded on all sides with such continuations of the common fascia, and such particular expansions of the ham-string and other muscles, as by adding outwardly successive layers to the capsule, brings it to a considerable degree of strength.

3. The capsule, having no stress upon its fore part, is very thin upon its fore part, viz., at the sides of the patella, but is strengthened at the sides by fair and distinct ligaments, going from point to point of the three great bones, and so large and particular as to deserve, more than any others in the body, the name

of LATERAL LIGAMENTS. At the back part of the joint the same strength is not required as at the sides; yet it must be stronger than at its fore part, wherefore it is strengthened by the additional bands, which are sometimes general and confused, but often so perfect and distinct as to be known by the name of the POSTERIOR LIGAMENT of WINSLOW; and as the lateral ligaments prevent all lateral motions, this strengthening of the capsule serves as a check-band behind.

4. It is only in the greatest joints that we find the additional security of INTERNAL LIGAMENTS; and the only joints where they are perfect, are the joints of the hip and of the knee; the former having its round, or rather triangular ligament, which secures the great ball of the thigh-bone, and fixes it in its place; the latter having its crucial ligaments, which, coming both from one point nearly, and going the one over the face of the tibia, and the other down the back of that bone, serve the double purpose of binding the bones firmly together, and of checking the larger and dangerous motions of the joint, the back ligament preventing it going too far forwards, and the fore ligament preventing it bending too much.

5. A MOVING CARTILAGE for facilitating motion and lessening friction is not common, but is peculiar to those joints whose motions are very frequent, or which move under a great weight; such are the inner head of the clavicle, the articulation of the jaw, and the joints of the wrist and of the knee; and it is in the knee that the moveable cartilages have their most perfect forms and use, are large, flat, and semilunar, to correspond with the forms on the head of the tibia; thicker at their outer edges, to deepen the socket; and though moveable, yet so tied with ligaments, as never to go out from their right place.

And, 6. The mucous folicular bundles of fat, and the bursæ mucosæ, which complete the lubricating apparatus of the joint, and the mucous frenulæ or ligaments, which both conduct the mucous fringes and keep them in their place, are more perfect in the

knee, and greater in number and size, than in any other joint.

I may well call this the most complicated, and (by daily and melancholy proofs) it is known to be the most delicate joint of the body.

LIST OF THE LIGAMENTS OF THE KNEE-JOINT.

External to the capsule these:

1. Ligamentum Patellæ.
2. Ligamentum Laterale Internum.
3. Ligamentum Laterale Externum Longum.
4. Ligamentum Laterale Externum Breve.
5. Ligamentum Posticum Winslowii.

Within the capsule these:

6. Ligamentum Mucosum.
7. Ligamentum Alare Majus.
8. Ligamentum Alare Minus.
9, 10. Ligamenta Crucialia.
11. Ligamentum Coronarium.
12. Ligamentum Transversale.
13, 14, 15. Ligamenta Cornuum Cartilaginum Semilunarium.

The most frequent accident to this joint is the sprain of the internal lateral ligament.

FIBULA.

The FIBULA is a support to the tibia in its various accidents; it gives a broader origin to the muscles, and it is the chief defence of the ancle-joint. It has no motion upon the tibia. The best authors speak of it as a symphysis, which classes it with the joinings of the pelvis, and excludes it from the list of true and moveable joints. It is united with the tibia by a sort of flat cartilaginous surface upon either bone; it is merely laid upon the tibia, not sunk into it. It is tied by a close capsule: it has an anterior and posterior accessory ligament; and is strengthened by the external lateral ligament of the knee, which adheres to this knob, and by the insertion of the biceps tendon, which is implanted into this point, and which spreads its expanded tendon over the fore part of the tibia, and holds the bones together; and the firmness of the fibula is further secured by the great

interosseous ligament, which goes from bone to bone. Towards the head of the bones the interosseous ligament is deficient.

ANCLE.

The ANCLE-joint owes less of its strength to ligaments than to the particular forms of its bones; for while the strong lateral ligaments of the knee guard it so that it cannot be dislocated till they are torn, the lower heads of the tibia and fibula so guard the foot, that when luxated these bones are often broken. First, the fibula is so connected with the tibia, at its lower end, that they form together one cavity for receiving the astragalus, with two projecting points, the fibula forming the outer ancle, and the tibia forming the process of the inner ancle; the joining of the fibula to the tibia here, is like that of its upper end, too close to admit of the smallest motion, and it is thoroughly secured by particular ligaments, one of which, passing from the fibula to the tibia on the fore part, is named the LIGAMENTUM SUPERIUS ANTICUM, consisting, in general, of one or two distinct flat bands. Another more continued and broader ligamentous membrane goes from the fibula to the tibia across the back part, and is named LIGAMENTUM POSTICUM SUPERIUS; the LIGAMENTUM POSTICUM INFERIUS being but a slip of the same. Next comes the capsule of the joint, which joins the astragalus to the lower heads of the tibia and fibula; it is thinner both before and behind than we should expect from the strength of a joint which bears all the weight, and the most violent motions of the body. But, in fact, the capsule every where serves other purposes than giving strength to the joint, and never is strong, except by additional ligaments from without; so it is with the ancle-joint, the capsule of which is exceedingly thin before; but it is strengthened at the back part, and especially at the sides, by supplementary ligaments: First, a strong ligament comes down from the acute point of the inner ancle, expands in a radiated form upon the general cap-

sule; adheres to it, and strengthens it, and is fixed all along the side of the astragalus, to the os calcis and naviculare. This ligament, coming from one point, and expanding to be inserted into a long line, has a triangular form, whence it is named LIGAMENTUM DELTOIDES; and while the general ligament secures the joint towards that side, the oblique fibres of its fore edge prevent the foot being too much extended, as in leaping; and its oblique fibres on the back edge prevent its being too much bended, as in climbing. But the ligaments of the outer ancle, tying it to the outer side of the astragalus, are indeed distinct, one going forwards, one going backwards, and one running directly downwards; one goes from the point or knob of the fibula, obliquely downwards and forwards to be inserted into the side of the astragalus; it is square and flat, of considerable breadth and strength, and is called LIGAMENTUM INTER FIBULAM ET ASTRAGALUM ANTERIUS. Another ligament goes perpendicularly downwards, from the acute point of the outer ancle, to spread upon the side of the astragalus, and of the capsule, and is finally inserted into the heel-bone; this is named the LIGAMENTUM INTER FIBULAM ET OS CALCIS PERPENDICULARE. A third ligament goes out still from the same point, to go backwards over the back part of the capsule, adheres to the back of the capsule, and strengthens it, and is named LIGAMENTUM INTER FIBULAM ET ASTRAGALUM POSTERIUS. There is nothing very particularly worthy of notice in the ancle-joint, for it is covered with cartilages, lined with a soft synovial membrane, and lubricated with fimbriæ and masses of fat, such as are found in all the joints. It is stronger than the other joints; it can hardly be luxated, without a laceration of its ligaments, and breaking of the bones which guard it at either side; and it is the great violence which is required for completing this dislocation, and the terrible complication of dislocation, fracture, and laceration of the skin, which makes this accident so dangerous beyond any other luxation.

RECAPITULATION.

From the fibula to the tarsus:
1. Ligamentum Fibulæ Perpendiculare.
2. Ligamentum Fibulæ Anterius.
3. Ligamentum Fibulæ Posterius.

From the tibia to the tarsus:
4. Ligamentum Deltoides.
5. Ligamentum Capsulare.

Accidents to this joint are very frequent: the sprain of the deltoid ligament is very frequent; so is the partial laceration of the perpendicular ligament of the fibula. We have to distinguish this last case from the sprain of the tendons of the peronæi muscles, which is a very frequent accident.

UNION BETWIXT THE BONES OF THE TARSUS.

The ASTRAGALUS, OS CALCIS, OS NAVICULARE, and all the bones of the tarsus, are united to each other by large heads, and have distinct and peculiar joints; besides which, the bones are cross-tied to one another by ligaments, so numerous and complicated, that they cannot nor need not be explained. They pass across from bone to bone, in an infinite variety of directions, some longitudinal, some transverse, and some oblique. There is a curious complication, which we may call a web of ligaments, covering the dorsum of the foot with shining and star-like bundles; these are called LIGAMENTA DORSALIA: each bone has its capsular ligaments for joining it to the next; each joint of each bone has its articulating cartilages always fresh and lubricated; each joint has, besides its capsule, flat strips of oblique, longitudinal, and transverse ligaments, joining it to the nearest bones. On the inside of the sole of the foot a strong ligament of a gristly nature passes across from the projecting point of the os calcis to the os naviculare, and forms an elastic spring, upon which the articulating head of the astragalus rests: this is called LIGAMENTUM CARTILAGINEUM, the central gristly part being the trochlea cartilaginea.

In the centre of the sole of the foot there are irregular bands, distinguished as PLANTARE MAJUS and MINUS, PLANUM and TERES. On the outside there is a principal ligament extending from the os calcis to the os cuboides: this is divided into two, both of them being called LIGAMENTUM INTER OS CALCIS ET OS CUBOIDES, but one is the long and the other the oblique.

The metatarsal bones have their capsular ligaments joining them to the tarsal bones; and they have ligaments strengthening their capsules, and tying them more strongly to the tarsal bones; and as in the metacarpal bones, the several ranks are tied one to another by cross ligaments which pass from the root of one bone to the root of the next; so we have ligaments of the same description and use, holding the metatarsal bones together, both on the upper and on the lower surface of the foot; and all the ligaments of the foot are of great strength and thickness. The lower ends of the metatarsal bones have also transverse ligaments by which they are tied to each other. The toes have hinge-joints formed by capsules, and secured by lateral ligaments, as those of the fingers are; and, except in the strength or number of ligaments, the joinings of the carpus, metacarpus, and fingers, exactly resemble the joinings of the tarsus, metatarsus, and toes.

But these ligaments, though helping to join the individual bones, could not have much effect in supporting the whole arch of the foot. It is further secured by a great ligament, which extends, in one triangular and flat plate, from the point of the heel to the roots of each toe. This is named the APONEUROSIS PLANTARIS PEDIS, which is not merely an aponeurosis for covering, defending, and supporting the muscles of the foot; that might have been done on easier terms with a fascia very slight, compared with this; but the chief use of the plantar aponeurosis is in supporting the arch of the foot. It passes from point to point, like the bow-string betwixt the two horns of a bow, and after leaping, or hard walking,

it is in the sole of the foot that we feel the straining and pain; so that, like the palmar aponeurosis, it supports the arch, gives origin to the short muscles of the toes, braces them in their action, and makes bridges under which the long tendons are allowed to pass: it comes off from the heel in one point; it grows broader in the same proportion as the sole of the foot grows broad. It is divided into three narrow heads, which make forks, and are inserted into the roots of the second, third, and fourth toes; and the great toe and the little toe have two smaller or lateral aponeuroses, which cover their own particular muscles, and are implanted into the roots of the great toe and of the little toe.

The bursæ mucosæ surround the ancle and foot in great numbers. None of them having any very direct connection with the joint, and most of them accompanying the long tendons as they pass behind the ancle, or in the sole of the foot, are of that kind which we call tendinous sheaths. First, there are sheaths of two or three inches long, which surround the tendons of the tibialis posticus, and of the peronæi muscles, as they pass down behind the ancle. The sheaths of the peronæi begin from that point where the tendons first begin to rub against the bone, and are continued quite down into the sole of the foot; making first a common sheath for both tendons, and then a bursa peculiar to the tendons of the peroneus brevis muscle, and about an inch in length. When the peronæus longus begins to pass under the sole of the foot, the sheath which enclosed it behind the ancle is shut, and a new bursa begins; in the same manner where the tendons of the flexor pollicis, and flexor digitorum pedis, pass behind the inner ancle, a bursa of three inches in length surrounds them, and facilitates the motion. As the tendons of the flexor muscle go under the arch of the foot, they lie among soft parts, and rub chiefly against the flesh of the massa carnea, and the belly of the short flexor muscle: but whenever they touch the first joints of their toes, they once more rub against

a hard bone. New bursæ are formed for the tendons; each bursa is a distinct bag, running along the flat face of the toe, and is of a long shape, and the tendon is carried through the centre of the lubricated bag, so that we see once more, that there is no true distinction betwixt bursæ mucosæ and tendinous sheaths; nor betwixt the tendinous sheaths and the capsules of joints.

Joints have been arranged under various forms, as shown in the beginning of this chapter, but not with much success; and I do not know that enumerating the joints in any particular order will either explain the motions of individual joints, or assist in recording their various forms; some joints are loose and free, capable of easy motions, but weak in proportion, and liable to be displaced; such is the JOINT of the SHOULDER, which rolls in every direction; other rolling joints, more limited in their motions, are better secured with ligaments of peculiar strength; such is the JOINT of the HIP, where the ligaments are of great strength both within and without; some wanting all circular motions, are hinge-joints, by the mere form of their bones; such are the LOWER JAW, the VERTEBRÆ, the ELBOW, and the ANCLE-JOINTS; some are hinges by their ligaments, which are then disposed only along the sides of the bones; such are the KNEE, the RIBS, the FINGERS, and the TOES. Some joints partake of either motion, with all the freedom of a ball and socket-joint, yet with the strength and security of the strictest hinge: thus the WRIST having one joint by which its turning motions are performed, and another joint by which it rolls, has the two great endowments so rarely combined in any joint, of the freest motion, and of great strength; so also has the HEAD, by the combination of two joints of opposite uses and forms; for its own condyles play like a mere hinge upon the atlas, and the axis of the dentata secures all the properties of a circular joint; this combination gives it all the motions of either joint, without their peculiar defects. But there is still a third order of joints, which have such an

obscure and shuffling motion, that it cannot be observed. The CARPUS and METACARPUS, the TARSUS and METATARSUS, the TIBIA, with the FIBULA, have these shuffling and almost immoveable joints; they are not intended for much motion among themselves, but are appointed, by a diffused and gradual yielding, to facilitate the motions of other joints.

OF THE BURSÆ MUCOSÆ.

The BURSÆ MUCOSÆ are little bags or sacs, placed betwixt the tendons and bones, where there is much friction. By the smoothness of their inner surfaces, and the lubrication of their surfaces, by a fluid similar to the synovia, they act the office of friction wheels in machinery, and take off the too severe pressure or friction from the bone or tendon. As they are of a structure similar to the apparatus of joints, they are subject to similar diseases. This most common disease is a kind of dropsy, which produces a puffiness or compressible swelling around the joint. Although we have mentioned the principal bursæ, in treating of the joints and the muscles, yet we consider it right to enumerate them here.

In connection with the SHOULDER-JOINT, these:

1. A very large bursa under the acromion, and betwixt it and the head of the humerus.

2. Betwixt the head of the clavicle, and the coracoid process of the scapula.

3. Upon the capsule of the shoulder-joint, under the tendon of the subscapularis muscle.

4. Under the deltoid muscle.

5. Under the tendon of the latissimus dorsi.

The principal bursæ around the ELBOW-JOINT, are these:

1. Betwixt the tendon of the biceps flexor cubiti, and the radius.

2. Over the round head of the radius, and below the extensor muscles.

3. On the olecranon and end of the humerus, under the triceps tendon.

About the WRIST, these:

1. A large bursa betwixt the flexor tendons, and the carpus.

2. On the trapezium.

3. On the pisiforme.

4. On the back of the carpus, and under the extensor carpi radialis.

5. Betwixt the ligament of the wrist, and the tendon of the extensor carpi ulnaris.

Besides these sacs or proper bursæ, sheaths surround the tendons of almost all the muscles about the wrist-joint.

On the PELVIS, these:

1. A large bursa betwixt the glutæus maximus, and the vastus externus.

2. Betwixt the capsule of the hip-joint, and the psoas and iliacus internus.

3. Under the pectinalis.

4. A large one on the surface of the trochanter major, under the glutæus maximus.—Also, under the glutæus minimus.

5. On the os ischii, under the origin of the biceps.

6. Under the tendons of the rotators of the thigh-bone.

In the THIGH, and around the KNEE-JOINT, these:

1. Under the tendon of the quadriceps, and communicating with the knee-joint.

2. Under the ligament of the patella.

3. Betwixt the insertion of the semimembranosus, and the origin of the gastrocnemius.

4. Over the internal lateral ligament of the knee-joint.

5. Under the popliteus.

N.B. Several irregular bursæ around the tendons inserted into the tibia and fibula.

Around the ANCLE-JOINT.

All the principal tendons which cross the ancle-joint have bursæ under or around them, as the tendon of the tibialis anticus, the extensor proprius, the extensor digitorum, the peronæus longus and brevis. There is also a proper bursa betwixt the tendo

Achillis and os calcis. Another under the flexor longus pollicis; and also under the flexor longus digitorum, and the tibialis posticus.

These bursæ it is necessary for the surgeon to know, because after sprain and injuries, effusion takes place in them, and they present a puffy swelling over the joint, not easily understood, without the recollection of the natural anatomy.

OF THE CIRCULATING SYSTEM.

We have already understood that a continual revolution or change of the material of the animal frame is necessarily connected with life. The living principle may be joined to the animal or vegetable matter, and remain in a latent state *; but when its presence is betrayed by action, it has begun a course of existence through certain defined stages, and during this active condition, all the material of the frame performs a continual revolution.

While solids are necessary to the constitution of the frame, fluids are necessary to these internal changes. From the fluids the solids are formed, and the solids are again broken down and change their condition of aggregation, and become fluid, and circulate in the vessels. The fluid blood and the blood vessels are therefore necessary to all the operations of life, since without them the revolution of solids into fluids, and fluids into solids, could not take place; the body would be stagnant and fixed, and no better than a machine, which being broken or wasted, possesses no power of reparation.

The Hunters began their demonstration of the system by exhibiting the condition of the blood, and the splendid consequences which attended this mode should incline us to follow their example.

* Mr. Hunter, in his lecture, illustrated the condition of life in the seed before vegetation, or in the egg before incubation, by the discoveries of Black, of the presence of heat in bodies in an insensible state.

QUALITIES OF THE BLOOD.

Blood is a fluid of a rich and beautiful colour: it is vermilion-coloured in the arteries, strong purple in the veins, and black, or almost so, at the right side of the heart, and varies somewhat in the depth of its colour in certain parts of the body; it feels thick and unctuous betwixt the fingers, and is of a slightly saline taste. The quantity of blood in the body is estimated to be thirty pounds in a man weighing one hundred and fifty pounds; or one fifth of his weight; and it is supposed that three fourths of this is in the veins, and the remaining fourth only in the arteries. In various individuals, but much more in different animals, it varies with their functions and manner of life; it is different in birds, in fishes, in insects; it is red or pale, warm or cold, in different classes of animals: and from this last variety comes our division of animals into those of warm and cold blood. When drawn from a vein, the blood spontaneously coagulates in about three or four minutes, and at this time heat is evolved and the temperature is raised 7 or 8 degrees, and carbonic acid gas is evolved. *

It is by the most simple and natural methods that we examine the blood; since when drawn from a vein it almost spontaneously resolves itself into the CRASSAMENTUM, the SERUM, and the RED GLOBULES, suspended in the crassamentum, and forming a part of it. In a cup of blood, the crassamentum, or clot, the hepar sanguineum, as it was called long ago, floats in the serum; the red globules are engaged in this clot, and give it colour; the serum may be poured off; and the coagulum may be washed till it is freed of the red parts of the blood, and then the red particles are found in the water with which the coagulum was washed, and the coagulum remains upon the strainer, little reduced in size, pure and white, the proper fibrin. Or we may separate this

* *Brande.*

part by a method which Ruysch first taught us; we may, while the blood is congealing, stir it with a bunch of rods, when the pure and colourless fibrin gathers upon the rods, and the serum, with the red particles suspended in it, remains behind. The coagulable part was called fibrin, from the fibrous appearance it assumed in this experiment, a name it has retained.

The red globules, as we have observed, are not universal; yet in all creatures, even in colourless insects, there seem to be formal particles in the blood.

The red globules of the human blood are easily seen; they are best examined with a simple lens, the globules being diluted in serum and laid upon an inclined plane, not in water, which dissolves them quickly, but in serum, which has the property of preserving their globular form. The watery solution of this part of the blood turns the syrup of violets green, and contains soda and albumen. The size of the particles of the blood varies in various creatures: it is asserted that, in the fœtus, they are bigger than in a grown animal; and although Leeuwenhoek thought it essential to his doctrine to say that they were alike in all creatures, there are, in respect to the size of the animals, the strangest reverses. The Skate has red globules much larger, and the Ox has globules much smaller than those of a Man. Fish have large globules, Serpents smaller ones, and Man smaller still. In Man the diameter of each globule has been estimated not to exceed the five thousandth part of an inch.

There is in the effect of lenses, or in the nature of these globules, some strange refraction, by which there seems a darkness in the centre of each globule, and thence a deception which has been universal; so that no single description has tallied with that which went before. Leeuwenhoek believed that he saw them consisting each of six well-compacted smaller globules. Hewson believed that they were bladders, which had within them some central body,

loose and moveable; that often the central part might be seen rolling in its bag; and that sometimes the bladder was shrunk and shrivelled around the central body, and could by putting a drop of water upon it, be plumped up again. The Abbé Torre examined them with simple lenses too; but they magnified so highly, that from this cause all his noisy mistake has arisen; for he used not ground lenses but small sphericles of glass formed by dropping melted glass into water; they magnified so much, that to him the central spot appeared much darker; he said that these were not globules, but rings. He sent his sphericles of glass and his observations from Italy, his own country, to our Royal Society; and for a long while, though nobody could see them, still the public were annoyed by Abbé Torre's rings. Falconer, with all the zeal of a friend, published Hewson's discoveries after he was dead; lamenting, as we all must do, the loss of a promising young man. Falconer thought he saw these globules, not as spheres, but as flattened spheres; he thought he saw them often as they rolled down the inclined plane upon which he placed them, turning their edges, their sides, their faces, towards the eye; he even compared their flatness with that of a coin. Many authors have conjectured that these globules are compressed when they come into narrow passages, and expand again when they get into wider arteries. This Reichell says he has seen, and Blumenbach believes; but Blumenbach, less easy of belief with regard to all these strange forms ascribed to the particles of the blood, pronounces his dissent in plain terms. "They appear," says he, "to my eye no other than simple globules apparently of mucus: that lenticular or oval form which authors speak of, I have not seen."

The following are their chief properties with regard to the rest of the blood. When blood stands, the red globules fall to the bottom, because they are heavier than the other parts of the blood; and although the fibrin entangles them while it is forming, still it is to be noticed that the cake is always redder

at the bottom; and when by circumstances of constitution this coagulation is very slow, some globules escape the grasp of the coagulum, and the serum is tinged with red, and the cake, though coloured at the bottom, is white at the top, and thus the clot is said to have the buffy coat. The globules preserve their form only while in the blood, and seem to be supported more by the qualities of the serum than by their own properties; for if mixed with water, they mix easily, and totally dissolve; the water is red, but the globules are gone: when we mean to preserve their forms for experiment, we must keep them in serum. I have looked upon the vitality of the blood as the cause of its fluidity. It coagulates most slowly when inflamed, which of course permits the globules to gravitate and the buffy coat to be formed. Its quantity, in regard to the whole mass, varies so, that the appearance of the blood is an index of health or disease: in disease and weakness, the blood is poor and colourless; in health and strength, it is rich and florid; by labour, the fibrin and red particles may be accumulated; in hard working men they abound; they may be accumulated by exercise into particular parts, as in the wings of Moorfowl or Pigeons, and in the legs of common Hens. In short, the red globules are numerous in health; in large and strong creatures; and in the centre of the system. In fishes the flesh is colourless; in such a system, particular glands only, or viscera, as the liver, stomach, or spleen, are coloured with blood, and but a small proportion circulates in the other parts.

The redness of these particles is a peculiarity. The chemical physiologists ascribed it to iron contained in the blood. But the present opinion is, that there is not more iron in the red particles than in the other component parts of the blood.

COAGULUM OR CRUOR.

The self-coagulating part of the blood, the cake which is left when we wash away the red globules,

that which has been called the gluten, and now the fibrin, is by far the most important part of the mass, the most universally diffused in the animal system, the most necessary for the supply and growth of parts. It spontaneously concretes, and neither heat nor cold, nor dilution, will prevent its coagulation. The proportion of crassamentum to serum is $56\frac{1}{7}$ per cent. It encreases with the vigor of the system. Circulating in the vessels, it furnishes the solids of the body; when washed, it is white, insipid, extremely tenacious, and very fibrous, and can be drawn out; and it is the coagulation of this part that makes the long fibrous strings which we find in the tub when bleeding a patient in the foot in very hot water. Being slightly dried, it shrinks into a substance like parchment; being hardened by heat, it becomes like a piece of horn or bone: when burnt, it shrinks and crackles, with a very fetid smell, like the burning of feathers, wool, flesh, or any other animal substance; by which we know it to be the part of the blood which is the most perfectly animalized, and the most ready to be assimilated with the living solids. When distilled, it gives ammoniacal salt and alkaline water, and a very thick heavy fetid oil, and much mephitis, which are the marks of the most perfect animal nature; and after burning it, the residuum is a phosphate of lime, or in other words, the earth of bones.

What takes place within the living and active blood vessels cannot be made matter of demonstration; but there is no reason to doubt that an important change is wrought upon the contained fluid in the moment of secretion, during that change, when from a fluid it becomes a component solid of the body. We see how the greater part of the body is composed of fibrin, and the analysis of any single part confirms this. A muscle being squeezed, and thoroughly cleansed of blood, washed in spirits of wine, and again cleansed, is seen plainly to be but a peculiar form of coagulable lymph or fibrin. A bone being infused in any mineral acid, or in vinegar, its earthy

parts are dissolved even to its centre; it becomes soft and flexible, still retains the form of a bone; but what remains consists principally of coagulable lymph. Fourcroy has said that coagulable lymph is that part upon which nature fixes irritability, or the contractile power; he should have added, "but this substance is moreover, in the animal body, the basis of every part which possesses life." The membranes, ligaments, tendons, periosteum, and all the white parts of the animal body, consist chiefly of this. It is this part, then, which is secreted by the vessels for repairing the waste, and the accidents of the body.

THE SERUM.

The serum is the thinnest and most fluid of the parts of the blood, into which it spontaneously separates. It continues oozing from the crassamentum till the fourth day. It is a fluid like whey, of a yellowish, or rather greenish colour, of an unctuous or slippery feeling among the fingers; it is slightly saline, and contains various salts in solution, and turns vegetable reds to green. It coagulates with a heat much lower than that which makes it boil; being dropped into hot water it coagulates as it falls.

But by this influence of heat the whole serum does not coagulate, but only the albumen, a substance like the white of an egg: what remains fluid is the serosity. On cooling, the serosity coagulates like size or jelly. This coagulation is owing to the albumen dissolved in the water; and the water being evaporated it leaves the albumen in the form of size or glue, or it may be precipitated from the water by various re-agents, but especially by tanin, and by alcohol. After the separation of the albumen, there remain only the salts in watery solution; these are muriates of soda and of potash, muco-extractive matter, subcarbonate of soda, sulphate of potash, phosphate of soda, and phosphate of lime.*

* The late Dr. Marcet makes the serum give the following products: — *water*, 900 parts; *albumen*, 86.80; *muriate of potash and soda*, 6.60; *muco-extractive matter*, 4; *subcarbonate of soda*, 1.65; *sulphate of potash*, 0.35; *earthy phosphates*, 0.60.

We perceive that the materials, of which the body is constructed, are contained in the blood, or formed from that fluid. It is true that we find in the body various substances, which do not exist formally in the blood, but which are new compounds out of the materials, which, by the imperfect aids of chemistry, we discover in it.

LIFE OF THE BLOOD.

Mr. Hunter, in forming his suite of preparations of the incubated egg, was led to reflect on the freshness of the yolk and the white of the eggs which are fit for incubation, while placed in circumstances which should quickly have produced putrefaction. What can it be, he said, which thus counteracts the chemical decomposition and prevents putrefaction, but the principle of life? He was thus led to make experiments, which ascertained that the same principle which in the egg prevented putrefaction, resisted cold. Life, according to these suggestions, was not a result of organization, but a principle added to the material, which might be either fluid or solid. Philosophically considered it is equally intelligible, that life shall be united to a fluid as to a solid; but we are more familiar with the latter, though we do not understand the mode of union more perfectly. It will however reconcile us to the fact to remember, that, in regard to the animal frame, solidity and fluidity are terms referable to different conditions of aggregation of the same substances; all parts of the body being in that state of revolution whilst there is life, that they are at one time fluid and at another solid. A particular and permanent figure of parts in the animal body, is necessary to mechanical action, but not required for the mere presence of life; though the blood may have no motion in itself, and yet it may have the principle of life added to it. Thus Mr. Hunter argued, and then he said, Can we deny life to this fluid which becomes the means of life, conveying it to the other

parts of the body, even to the nerves themselves? For nerves do not convey life, but only direct the motions of parts, and without the blood the nerves themselves cease to be alive. Health, Mr. Hunter conceived, to consist in the harmony existing betwixt the solids and fluids, and betwixt the blood and its containing vessels, and in disease there is also a consent betwixt them; if solids are disordered, the blood also puts on a diseased appearance; if it circulates in inflamed solids, it acquires an inflammatory disposition, and the condition is marked by signs.

I have said, "that the blood is a fluid of a rich and beautiful colour; vermilion-coloured in the arteries, dark purple in the veins, and black, or almost so, at the right side of the heart." When we open the thorax of a living Dog, the lungs collapse, the heart soon ceases to play, the Dog languishes, expires, is revived again when we blow up its lungs:—then begins again the motion of the heart, the black blood of the right auricle is driven into the lungs; the blood goes round to the left side of the heart of a florid red; and this purple blood of the veins converted into the vermilion blood of the arteries, and the change happening so plainly from access of air, is a phenomenon of the most interesting nature, and binds us to look into the doctrines of chemistry for the solution of a phenomenon to which there is in all the animal economy nothing equal.

It is the study of air and aërial fluids that has brought to light all the beautiful discoveries of which modern chemistry can boast. The simplicity of the facts in chemistry, the correctness of the reasoning, the grandeur which now the whole science assumes, is very pleasing; and leaves us not without hope, that by this science, all others, and ours in an especial manner, may be improved.

The older chemists were coarse in their methods, bold in their conjectures, in theory easily satisfied with any thing which others would receive. They condescended to repeat incessantly the same unvarying process over each article of the materia medica;

and among hundreds of medicinal plants which they had thus analysed, they could find no variety of principles, nor any other variety of parts and names than those of phlegm, and oil, and alkali, and acid, and sulphur, and coal. By this they disburthened their consciences of all they knew, pleased their scholars, and set the physicians to work, forming magnificent theories of salts, sulphurs, and oils; for such has ever been the connection of chemistry with physiology, that, good or bad, they have still gone hand in hand.

The older chemists thought that they had arrived at the pure elements, while they were working grossly among the grosser parts of bodies. They could know nothing of the aërial forms of bodies, for they allowed these parts to escape. When their subjects, by extreme force of heat, rose upwards in the form of air, no further investigation was attempted; it was supposed that the subject of their operation was consumed, annihilated, wasted into air, and quite gone. When they thus stopped at airs, they stopped where only their analysis became interesting or simple; stopping where they stopped, among their oils and sulphurs, they made their science a mere rhapsody of words. Philosophy they considered so little, as not to know that the lightest air is really a heavy body, and that with weight and substance other properties must be presumed.

Modern chemistry begins by assuring us, that these airs are often the densest bodies in the rarest forms; that airs are as material, as manifest to the senses, as fairly subject to our operations, as the dense bodies from which they are produced: that it is heat alone (a substance which irresistibly forces its way into all bodies) that converts any substance into the aërial form: that some bodies require for their fluidity merely the heat of the atmosphere, and so cannot appear on this planet in any solid form: that others require some new principle to be added, in order to give them the gaseous or aërial form: that others require very intense heat to force them into

this state; but that all aërial fluids arise, or must be presumed to arise, from some solid body or basis, which solid basis is dilated by heat into an air. The solid basis of some airs can be made apparent, as of fixed air, which proceeds from charcoal; others, as oxygen or azotic air, (the great constituents of our atmosphere,) cannot be produced to view in any solid form. But those airs which cannot be exhibited in any solid form, can yet be so combined with other bodies as to increase their weight and give them qualities of a very peculiar nature; and these airs can be alternately combined with a body and abstracted again, adding or abstracting from its weight and chemical properties, not only in a perceptible, but in a wonderful degree; so that these abstractions and combinations constitute some of the most general and important facts. When the old chemists, then, neglected to examine these airs, they refrained from examining the first elements of bodies at the very moment in which they came within their power.

That these must be the most material and important facts in all the science, it is easy to explain; for chemistry, ever since it has been a science, has rested upon one single point. There are certain great operations in chemistry which we perceive to have the strictest analogy with each other, or rather to be the same: the operations are the combustion of inflammable bodies, the respiration of animals, the calcination of metals; and whatever theory explains one explains the whole. The older chemists observed, that when they burnt an inflammable body, the surrounding air was contaminated, the substance itself was annihilated, nothing remained of its former existence but the foul air; and they supposed that this inflammable body consisted of a pure inflammable principle, which was the substance which spoiled the air, lessening its bulk, and making it unfit for supporting any longer either combustion or animal life. When an animal breathed in confined air, they found the phenomenon still the same; the animal contaminated the air, and expired itself; left the

air unfit for burning or breathing, loaded, as they supposed, with the inflammable principle or phlogiston. When they calcined a metal, (which is done merely by heating the metal and exposing it to air,) they found, as in these other operations, the air contaminated, the metal losing its metallic lustre, ductility, and all the marks of a metal,—acquiring (in certain examples) new qualities, like those of some mineral acid, and becoming, of course, a most caustic drug; but above all, they uniformly observed the metal to increase in weight.

To account for all these discordant changes was the most difficult part of all: it was indeed easy to say, that combustion was the giving out of an inflammable principle to the air; and to say concerning respiration, that it was the business of the air to take away continually the superabundant phlogiston of the blood; but how a metal should pass from a mild to a most acrimonious and caustic state; and above all, how by the loss of its inflammable principle it should not lose in weight, but increase in weight! This was the Gordian knot which they had to untie, and which they cut lustily, betaking themselves, in defiance of all philosophy, to the absurd project of a principle of absolute lightness. They all agreed to call the phlogistic principle, a principle of absolute levity; and thus their doctrine stood for many years, viz. that when phlogiston, or inflammable principle, was added to the calx of any metal, as to red lead, by roasting it with any inflammable body—the metallic lustre, tenacity, ductility, were restored, and the metal became lighter withal, because it now had within it the principle of levity. But that when by heat and air it was calcined, this principle was driven out, and then the metallic lustre, tenacity, ductility, &c. were lost by the absence of the inflammable principle upon which they all depended; but the weight of it was increased, for the principle of levity was gone. This is the brief abstract of the theory to which the very best chemists have addicted themselves down to the present times.

But the chief perfection of modern chemistry is, that its apparatus is so perfect, that it can employ exactly a certain quantity of air in calcining a metal; it can collect that air again to the twentieth part of a grain; it can prove whether the metal has really been giving out any inflammable principle to the air, or whether it has received matter from the air, and how much expressly it has gained or lost. Modern chemistry proves to us, that it is not the loss of any principle that endows a metal, for example, with negative powers; but the direct acquisition of a new principle, which endows it with positive powers.

Upon our atmosphere and its surprising harmony with all parts of nature; with animal and vegetable life; with water, metals, acids, and all the solid bodies into which it enters—much more depends than it is easy to conceive. Could we have supposed that it was the cause, not merely of life in all living creatures, but almost the cause of all the properties that reside in the most solid forms? Could we have supposed that air rendered heavy bodies heavier, changed metals into the most caustic substances, converted many bodies into acids, changed inflammable air into the pure element of water, which at least we have hitherto conceived to be pure.

The atmosphere contains various gases or airs; but one only, viz. vital air or oxygen gas, is useful to respiration, combustion, and animal life; that purer air must, like every other, arise from some solid basis: that basis cannot be shown in any substantial form, but it can be combined with many various bodies, so as to give them an increased weight and new qualities; and thence we presume to say, whenever we see a body, by such a process, acquiring such qualities, that it acquires them by absorbing the basis of pure air; for pure air is nothing but this presumed basis dilated into the form of air by heat; and when it combines with any body, it gives out its heat; so that in all these processes heat is produced. And although inflammable bodies, metals, acids, &c. seem very distinct from each

other; although combustion, calcination, and the forming of acids, are processes seemingly very unlike; yet they are all in their essential points the same, viz. a change of qualities and a production of heat in consequence of the absorption of pure air; and there is a certain analogy betwixt breathing and these chemical processes, which, however, the chemists have carried too far.

First, when an inflammable body is BURNT, or consumed by fire, the basis of pure air is combining with the combustible body; the air is entering into a new combination, and therefore must give out its heat; it combines rapidly, gives out its heat rapidly, is wasted; the inflammable body burns and seems to be consumed; but if we catch that air which escapes from the inflammable body, we find it to be equal exactly to the whole weight of the air and of the burning body that have been consumed; and this air consists of two parts, viz. of the substance which was burnt, and of the basis of pure air. Thus, for example, when we burn charcoal or carbon, the whole substance of it, weight for weight, is converted into an air, which is called fixed or carbonic acid gas; the same which is discharged from stoves, the same also which is found in pits, the same which oozes through the ground in the Grotto del Cane, the same which floats upon the surface of fermenting vats, and which is so much heavier than common air that it can be taken out from a vat in basins, and poured from dish to dish. Combustion, then, is a process which consists in the rapid assumption of the basis of pure air, and a consequent conversion of the burning body into an air or gas endowed with peculiar qualities and powers.

So chemists have supposed that the function of respiration differs from these only in the rapidity of the process. So far it is true, that the carbon of the blood, secreted and thrown off from the lungs, unites to the oxygen of the atmosphere. But it is a mistake to suppose, as they have done, that the blood becomes oxydated like a metal; there is no proof that

oxygen unites to the blood. It appears only to be the means of involving and extricating the carbon of the blood, and converting it into carbonic acid gas. No doubt there is a balance preserved betwixt the function of the lungs in producing carbon and the condition of the atmosphere to receive it; for our atmosphere is so tempered that no more than twenty-seven parts of a hundred consists of pure air, as we term it, that is, of oxygen. This is the reason that even burning as well as breathing are slow processes, and that an animal, if made to breathe pure air, or vital air, as it is called, gets oxygen too rapidly supplied, is inflamed quickly, and dies.

As there are various marks of the influence of oxygen on the blood, there are terrible proofs of its importance in the system, and how miserable the person is who has imperfect organs, or an ill oxygenated blood. It signifies not to our present purpose, whether any thing is actually given to the circulating blood during respiration, or if only the carbonaceous matter be separated and carried away; the contact of blood with a certain portion of pure air or oxygen is absolutely necessary to the continuance of life.

Nature, disregarding all occasional supplies, as by the absorption of the skin, the assimilation of aliments, &c. has appointed one great organ for the oxygenation of the blood, viz. the lungs. In opening the breast of a living creature we best see the connection of respiration with the great system; but it is out of the body that we can best understand its particular effects upon the BLOOD.

The most obvious effect of air is its heightening the colour of the blood. If we expose blood to fixed air, or azotic air, it continues dark; these fluids communicate nothing, they have no effect on the colour of the blood: when we expose blood to atmospheric air, it assumes a florid colour; for in the atmosphere there is a large proportion of oxygen gas; if, lastly, we expose it to oxygen gas, the purest of all air, as chemists would formerly have expressed

themselves, it grows extremely florid: and it must either be that the carbon in the blood is attracted, and floated off, and united to the oxygen, or oxygen is absorbed into the blood; and the former opinion prevails.

Blood, when exposed to the air, becomes red chiefly on the surface; it remains black beneath, but by turning up the clot to the air all the surfaces become red. If air be blown into a tied vein, the blood which was black in the vein becomes florid; and when the air is pressed out again, it becomes black. If the air-pump be exhausted over a dish of blood, the blood becomes dark in the vacuum; and it becomes florid when the air is allowed to rush in again. If you expose blood in a moist bladder, the blood is oxygenated through the walls of the bladder; which brings this experiment as close as may be to the phenomenon of blood oxygenated through the cells of the air vesicles of the lungs, and through the coats of the blood-vessels which circulate the blood upon those air vesicles.

When we open a Frog, or Newt, or other amphibious creature, we see a long and slender artery accompanied by a slender vein, running from top to bottom along the whole surface of their lungs; and while their heart continues to beat, we see this pulmonic artery black, the vein red, the lungs themselves most delicate and pellucid, like the swimming bladder of a fish: on the other hand, when we have an opportunity of seeing the extremities of the arteries and veins in the circulation through the body, the blood of the vein is dark and that of the artery red; so that surgeons distinguish venous and arterial blood in this way.

From these facts we may understand why the blood of the womb, of sinuses, of varices, and of all stagnant veins, is so dark; and why that blood is so very pure and florid which is coughed up from the lungs. Is not the face livid in apoplexies or strangulations, in hanging or drowning, in fits of passion or of coughing, or in any accident which interrupts

the lungs? The face of a child during a paroxysm of the hooping cough, is it not black? Is not the hand livid when the arm is compressed or tied up, and its blood prevented from returning to the lungs and heart? Are not tumours dark coloured from dilated veins which return their blood too slowly? The first effect of oxygenation is a reddening of the blood. The blood of ecchymosis, the blood of aneurismal bags, are all black; and the blood of varices is so very black, that the ancients said they were filled with atrabilis or black bile. The stripes, inflicted on a soldier as a punishment, are at first of the most lively red, but soon become black.

If we open the breast of a Frog and stop its breathing, we observe, first, its pulmonic blood florid, and the heart beating strongly; secondly, in half an hour the pulmonic blood has become dark, and the heart's motion has grown languid; in a little while the pulmonic blood becomes black, and the pulsation of the heart ceases: and, lastly, the trachea of the Frog being untied, and the creature allowed to breathe again, the blood becomes florid, and the heart acts.

We have stated the facts regarding this matter, as they have been brought forward, and as they appear. But a closer inspection of the phenomena will probably show that the oxygen is not in these instances the stimulus. But that the change produced upon the blood in respiration, makes that fluid more capable of supplying the irritability of the muscular fibre, and, consequently, of adding power to the heart. The load of carbon which the venous blood carries back from the circulation of the body, makes it incapable of adding to the irritability or contractile power of muscles. But when by purification in the lungs that carbon is carried off in form of carbonic acid gas, the colour of the blood is restored, and with it new powers.

By these views the facts stated above have a new light thrown on them, the heart does not become weak, because the black blood is not stimulant, but

because being black, and loaded with carbon, it is incapable of supporting the irritability of the muscular fibres of the heart.

OF THE HEART, ARTERIES, AND VEINS.

OF THE HEART.

OF THE MECHANISM OF THE HEART.

THE heart is placed nearly in the centre of the human body, and is itself the centre of the circulating system. The system of vessels which it excites and moves consists of arteries and of veins;—the arteries act with great strength, with a pulsation like that of the heart itself, and convey the blood over all the body; the veins are in greater number, exceedingly large, pellucid almost in their coats, incapable of that energetic action with which all the functions of the arteries are performed; they return the blood to the heart with a slow, equable, and gentle motion, and deposit at the right side a quantity of blood equal to that which is at each pulsation driven out from the left. The heart is placed betwixt the arteries and the veins, to regulate and enforce their action; to receive the blood from the veins by a slow dilatation, and to restore, by a sudden contraction, that force which the blood loses in passing round the circle of the body. But the heart has also another and more important office to perform; for by having four great cavities and two orders of arteries, it performs in the same instant two circulations, one for the lungs and one for the body; it receives from the lungs nothing but pure blood, it delivers out to the body nothing but what is fit for its uses: and this purifying of the blood, and this excitement of the arteries, are two chief points of

modern physiology, which every step of the following demonstration will tend to explain.*

It will be most easy to conceive at first the idea of a more simple heart, of one circle of actions, of one

simple circulation; of one bag for receiving, and another joined to it for propelling the blood. Indeed a heart consists merely of these essential parts; a GREAT VEIN, an AURICLE, a VENTRICLE, and a GREAT ARTERY: of a vein which returns the blood from all the body; of an auricle or smaller bag, which receives that blood and retains it till the action of the heart is relaxed; of a ventricle (which is the proper heart), strong, muscular, very irritable, and easily excited, into which the auricle pours its blood; of an artery which is allied to the ventricle in strength and action, (as the auricle is to the vein in the delicacy of its coats,) and which carries on the blood to the extremities of the body;—and the vein and artery meeting at their extremities in the body, and uniting, the whole is a circle, and the heart is the central power.

If an animal were not to breathe, its system might be exactly what is now described; it would have but one vein, one auricle, one ventricle, one artery; it would have one simple heart: but with us, and other breathing animals, it is not so; and I am now to describe a more complex and curious circulation. For suppose this blood, so essential to our existence, to have in it some principle of life, which is continually lost, or in its passage through the body, to be impregnated with something which should be

* Professor Blumenbach reckons the whole mass of blood in the body to be 33 pounds. He takes 75 as the average number of pulsations of the heart in a minute; and he supposes the heart expels two ounces of blood at every contraction. Proceeding upon these data, he calculates that the whole of the blood passes through the circulation in two minutes and a half.

thrown off, that principle must be continually renewed, or an opportunity given to send off what is offensive to life: the heart which fills the arterial system must not be taken from its appointed office, nor disturbed; nature appoints a second heart, which belongs entirely to this most important of all functions, viz. renewing the blood; and it may be renewed in many various ways. It might, for example, circulate in some peculiar viscus; in the fœtus it does circulate in such a mass, for the placenta is a thick and flat cake, whose office we know to be equivalent to that of the lungs, but whose structure we imperfectly comprehend: in the chick we see its blood circulating over the yolk, (for the yolk is inclosed within the membranes of the unhatched chick,) and we perceive the blood redder as it returns to the heart, and plainly changed: in fish we find the blood circulated over the gills, exposed thoroughly to the water in which they swim, and thus the gills perform to them the function of lungs. But in all breathing creatures, the lungs do this office; the lungs are, next to the heart itself, essential to life; in those who die from bleeding, we can perceive from the livor of the face, from the sobbing and struggles of the chest, from the regular convulsive sighs of those creatures which are butchered, rather a desire for air than a want of blood. It is for the purpose of this second circulation that nature has appointed in all the warm-blooded animals two hearts, a heart for the lungs and a heart for the body.

There are other varieties which distinguish animals into creatures of cold or of warm blood; for there are certain constitutions which do not require that the blood should be thus continually renewed. It is not because animals are amphibious, or go into the water, that they have peculiar lungs; for the Land Tortoise, the Newt, the Cameleon, never go into the water; yet they have membraneous lungs: nor indeed can the amphibiæ, as the Seal, the Porpoise, the Sea-lion, &c. dive and exist under water more than a man can do, though for whole days they lie in

herds basking upon the shore: it is their peculiar constitution to need less than other creatures the office of the lungs. The cold-blooded animals are generally creeping animals, sluggish, languid, cold, inert, difficultly moved, and tenacious of life to a wonderful degree. They can bear all kinds of stimuli; they can bear to have their heads, legs, bowels, cut away; and among other peculiarities of this constitution, they can live long without air: they will rise from time to time above water, if you allow them; they can bear again to be kept under water, if you force them: but if they can live long under water, they can also live at least as long after you have cut off their heads, or cut out their hearts. By all which it is clear that they cannot live without breathing. That this function is necessary to their existence: but that they are tenacious of life.

Of those cold-blooded creatures always either the heart or the arteries are peculiar; the heart is so in many amphibiæ, as in the turtle, where the heart seems to consist of three ventricles, but with partitions so imperfect betwixt them that they are absolutely as one: this one ventricle gives out both the great arteries; the blood of the lungs and the blood of the body are both mixed in the heart: and since there are two arteries conveying this mixed blood, if the two arteries be nearly equal in size, then it is just one half of the blood thrown out by the heart at each stroke that receives the benefit of the lungs. In many others, as the frog, the newt, the toad, the peculiarity is in the arteries alone: they have one single and beautiful heart; there is one large auricle as a reservoir for all the blood both of the body and of the lungs; there is one neat, small, and very powerful ventricle placed below the reservoir, having strength quite sufficient for moving both the blood of the lungs and the blood of the body; and this ventricle gives off an aorta, which soon divides into two branches, one for the body, and one for the lungs; and these of course have but half the blood of this heart exposed to the air: these also are

cold-blooded animals, of which take this as an example.

But all breathing creatures, such as are called animals of hot blood, have two hearts; the one heart is sending blood through the lungs, while the other heart is pushing its blood over the body; not the half only, but the whole blood which is sent by each stroke of the heart over the body must have first passed through the lungs; no blood can reach the heart for the body which has not been sent to it through the lungs, or, in other words, the veins of the lungs; and they alone feed the left side of the heart.

Words alone will never explain any of the endless difficulties which concern the mechanism of the heart; but at every point, in every kind of difficulty, in explaining the form, the parts, the posture, even the coats or coverings of the heart, I shall have recourse to plans, such as cannot fail to make all this intricate mechanism be easily conceived.

The most simple form of the heart, which is represented in the plan on page 513, has a vein marked (a),—an auricle (b),—a ventricle (c),—an artery (d);—it has no provision for purifying the blood; it has no resemblance to that kind of heart which is connected with lungs; but the blood is received by the veins, falls into the auricle, is driven by its force

into the ventricle, by the ventricle it is thrown into the artery, and courses round all the body, till at length, reaching the extremities of the veins, it passes by the veins to the auricle a second time, and so this single circle is perfect.

The heart of the amphibious creature is represented in page 516; it is a frog's heart: it has the most simple form, and the fewest parts; it has the same vein, auricle, ventricle, and artery: but its great artery divides into two chief branches, of which —(d) the aorta goes to the body,—(e) the pulmonic artery goes to each side of the lungs.

The heart of a breathing creature is represented here in its most intelligible form; and the double circulation of the human body may be traced easily in the following way.—Here the heart of the lungs is set off from the heart of the body, being as distinct in office as in form and parts; on the right side is the heart of the lungs, on the left side is the heart of the body. —(*a*) Is the great

vein called vena cava from its immense size;—there is an ascending and a descending cava; the one brings the blood from the head and arms, the other brings the blood from all the lower parts of the body: they meet, and form by their dilatation a chief part of that bag which is called the auricle,—in it they deposit all the returning blood of the body, and thus present it at the right side of the heart to be moved through the lungs.—(*b*) Is the right sinus, or RIGHT AURICLE; it is in part formed

by a dilatation of these veins, but it puts on a strong and muscular nature as it approaches the heart; it is the first cavity of the heart, and, like all its parts, is strong and irritable; it is filled by the returning blood of the cavæ; it receives, dilates, is oppressed by this great quantity of blood; it is strongly excited to act; in its action the blood goes down into the ventricle or lower cavity of the heart.—(*c*) Is the RIGHT VENTRICLE, thick and strong in its walls, and of great muscular power; it is filled by the auricle, and is strongly stimulated both by the stroke of the auricle, and by the weight and quantity, and also, in some degree, by the qualities of the blood; its action is sudden and violent, and it drives the blood through all the system of the lungs.—(*d*) Is the PULMONIC ARTERY,—the artery of the lungs which receives all the blood of the right side of the heart; it is filled by the stroke of the right ventricle, from whose cavity it arises; it carries the blood in many branches through all the substance of the lungs; and thus that blood which had returned imperfect and robbed of its vital quality to the right auricle of the heart, is by this circulation through the pulmonic artery ventilated and renewed, and made fit for the uses of the system; and thus the lesser circulation, or the circulation of the lungs, the circulation of the right side of the heart, is completed, and the purified blood is brought round to the left side of the heart to undergo the greater circulation or the circulation of the body.

Thus it is from the extremities of this first circle that the second circle begins: it consists of like moving powers, of a vein, an auricle, a ventricle, and an artery; for as the right heart receives the contaminated blood of the body from the veins of the body, the left heart receives the purified blood of the lungs from the veins of the lungs. The VEINS OF THE LUNGS are sometimes four, sometimes five in number; they enter from each side of the lungs, and return the blood purified in the lungs to the left auricle of the heart.—(*f*) Is the LEFT AURICLE, smaller, but more muscular,

and stronger than the right; it receives easily whatever quantity of blood the lungs convey to it; it is irritated, contracts, forces the mouth of the ventricle, and fills it with this purified and redder blood.—(g) Is the LEFT VENTRICLE, whose form is longer, its fleshy walls thicker, its cavity smaller, its power greater far than that of the right side; this ventricle is thus small that it may be easily filled and stimulated, and thus strong that it may propel all the blood of the body.—(h) Is the AORTA or great artery of the body, arising from this left ventricle, just as the pulmonic artery arises from the right: the left ventricle, by its strong and sudden stroke, not only delivers itself of its own blood, but propels all the blood of the body, communicates its vibratory stroke to the extremest vessels, and excites the whole; this is the greater circle or circulation of the body, as opposed to the shorter circulation or lesser circle of the lungs.

That there are strictly two hearts, is now clearly made out; they are different in office; there are two distinct hearts, two systems of vessels, two kinds of blood, and two circulations. These two hearts might have done their offices, though placed in the opposite sides of the breast; it is in order to strengthen mutually the effect of each other that they are joined; for the fibres of the two hearts intermix; they are both inclosed in one membraneous capsule, viz. the pericardium; the veins, auricles, ventricles, and arteries correspond in time and action with each other, and harmonize in a very beautiful manner. But this, I believe, will be more easily explained by marking the succession of motions, by a suite of figures placed upon the several parts of the heart, by which the successive motions are performed.

Here I have joined the right and the left hearts; both that it may be seen how the left heart locks in behind the right heart, how the right heart comes to be the anterior one, and how the aorta seems to arise from the centre of the heart, while its root is covered by the great artery of the lungs; and also that the

synchronous parts, *i. e.* the parts which beat time with each other may be correctly seen.—(1) The CAVÆ are receiving the blood from all parts of the body, and in the same instant the pulmonic veins are receiving blood from the lungs. (2) The RIGHT AURICLE is gradually filling with the contaminated blood of the body; the left auricle, marked also with a second figure, is filling with purified blood from the lungs. (3) The RIGHT VENTRICLE is stimulated by its auricle, and throws its contaminated blood into the lungs; and in the same moment the left ventricle throws its purified blood over the body. (4) The PULMONIC ARTERY re-acts upon the blood driven into it by the heart; and in the same moment the aorta re-acts upon the blood thrown into it, and that re-action works it through all this great system of vessels from this the centre to all the extremities of the body.

Thus it is easy to perceive how the successive actions accompany each other in the opposite sides of the heart: (1) The two veins swell; (2) The two auricles are excited; (3) the two ventricles are filled with blood; (4) The two arteries take up and continue this pulsating action of the heart. It is thus that the two hearts assist and support the actions of each other, and there seems almost a physical necessity for their being joined; yet on the very best authority, and after deliberate dissection, we are entitled to affirm, that the heart is found, not with its apex sharp and conical, but cleft; the two ventricles plainly distinct from each other, and divided by a great space.*

* Latro, qui pœnas scelerum luebat, quando exenteraretur a carnifice, cor habuit singularis figuræ, mucrone non acuto, ut

OF THE PARTS OF THE HEART.

As yet I have explained only the general plan of the circulation, without having described those curious parts which are within the cavities of the heart, and which support the actions in this beautiful harmony and perfect order, each part subordinate to some other part, and each action succeeding some other action with perfect correctness, often without one unsteady motion or alarming pause, during the course of a long irregular life.

1. The VENÆ CAVÆ are two in number*; they are named venæ cavæ from their very great size; the one brings the blood from the upper, and the other from the lower part of the body, and they are formed of these branches: the upper vena cava (a), is properly termed the DESCENDING CAVA, because it carries the blood of the head and arms downwards to the heart: this great vein is properly a con-

fieri solet, sed bifido; ut distincti ventriculi manifestius externa facie apparuerint, dexter nempe et sinister, interjecto magno hiatu.—Bartholini Epist. p. 170. There are examples in the lower animals, of the hearts being actually in distinct parts of the System.

* Let the reader observe, that the whole of this description of the various parts of the heart is, as it were, an explanation of the plans: of which the first shows the right side of the heart, or the heart of the lungs opened; while the second shows only the left heart, or the heart of the body opened.

tinuation of the right jugular vein which joins with the right axillary vein, and then descends into the chest a great trunk; and in the upper part of the chest it is joined at (b)—by a great branch, containing the axillary and jugular veins of the left side, which, in order to reach the cava, crosses the upper part of the chest, and lies over the carotid arteries. The lower VENA CAVA, OF CAVA ASCENDENS, brings in like manner all the blood from the belly and lower parts of the body by two great branches. One, marked (c),—is the vein which lies in the belly along the right side of the spine, and brings the blood from the legs, the pelvis, and parts of generation, the kidneys, &c.; it is named the VENA CAVA ABDOMINALIS, because of its lying in the abdomen. Others marked (b),—arise in three or four great branches from the liver; they are named the branches of the vena cava in the liver, or the VENÆ CAVÆ HEPATICÆ; and these make up the lower cava: and the lower and the upper cavæ now join themselves at (e),—to form the right sinus of the heart (f).

2. The RIGHT SINUS OF THE HEART, marked (e), is of considerable extent; it is just the gradual dilatation of the two veins forming the auricle or reservoir which is incessantly to supply the heart; the veins grow stronger as they approach the sinus, and the sinus still stronger as it approaches the AURICLE or notched and pendulous part, and the auricle again approaches in its nature to the ventricle of the heart: for it is crossed with very strong muscular fibres, which make very deep risings and furrows upon its inner part. To say that these veins, or the sinus which they form, are not muscular, merely because they are not red nor fleshy, is very ignorant; for the ureters, arteries, intestines, the iris, and many other parts of the human body, are, at the same time, perfectly muscular and perfectly pale; and the heart of a fish is as transparent as a bubble of water, and yet is so irritable that after it is brought from market, if you lay open the breast, and stimulate the heart with any sharp point, it will renew its contractions, and in some degree the circulation.

3. The TUBERCULUM LOWERI should be looked for in this point, if it were not really an imagination merely of that celebrated anatomist. The whole matter is this; the two veins meet, not directly, but at a considerable angle within the vein, as at (g). Lower conceived a projection of the inner coats of the vein at this point much more considerable than what I have here represented. It was thought to do the office of a valve, to break the force of the descending blood, to defend from pressure that blood which is ascending from the lower cava, and to direct the blood of the upper cava into the right auricle of the heart; and in the place appointed for finding this tuberculum Loweri we can find nothing but on the inside the natural angle of the two veins, and on the outside some fat cushioned up in that angle in the line (h). Though generally wanting, I have found the tuberculum Loweri very distinct in the human heart. If we must assign a use for this angle and this inclination of the veins, it is certainly to direct the two streams of blood which meet here towards the opening of the ventricle.

4. The AURICLE is, as I have said, a small appendix to the great bag or sinus. It is small, semicircular, notched or scolloped, and somewhat like a dog's ear; whence its name. In general, we name the whole of this bag auricle; but by this plan the names of sinus and auricle must be easily understood. The point chiefly to be noted is this, that the veins, as they approach the auricle, are thin, delicate, transparent; that where they expand into the sinus they become fleshy, thick, and strong; that in the auricle itself the muscular fibres are very strong, have deep sulci like those of the ventricle; these strong fibres are what are named the MUSCULI PECTINATI AURICULÆ. Where these muscles run, as in cords, across the auricle, they are very thick and opaque; but in the interstice of each stripe or muscular fibre, the auricle is transparent, like the membranes of the veins; and when you look on the inner surface of the auricle, they stand out so distinct, and get so regular, that they

have a resemblance to the teeth of a comb; and thus they are named MUSCULI PECTINATI.

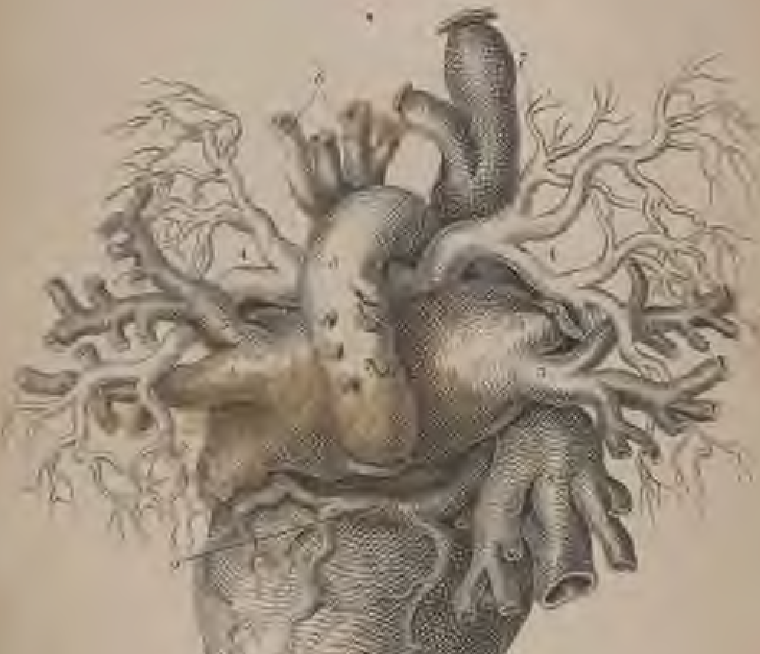
5. The VALVES of the AURICLE are placed at the circle (i), where the auricle enters into the ventricle, and the valves are marked (k): and how necessary these are for regulating the movements of the heart will be easily understood by considering the conditions in which the auricle and ventricle act. First, the cavæ pour in a flood of blood upon the sinus and auricle, with a continual pressure; the moment the auricle has contracted, it dilates, and it is full again; the pressure from behind excites it to act, and while it is acting, there is no occasion for valves to guard those veins whose blood is pressing forwards continually, because they are continually full, and have behind them the whole pressure of the circulating blood. But when the auricle acts, it throws its blood into the ventricle, fills it, and stimulates it; the auricle then lies quiescent for a moment, while it is gradually filling from behind with blood; but during this quiescent state the whole blood from the ventricle would rush back into it, were it not guarded by valves. The valves, then, which rise whenever the ventricle begins to act, are of this kind: there is, first, a tendinous circle or hole, by which the auricle communicates with the ventricle. It is called the ANNULUS VENOSUS, being that tendinous ring of the ventricle which is towards the venous system. The opening, OSTEUM VENOSUM*, is large enough to admit two or three fingers to pass through it; it is smooth, seems tendinous, is plainly the place of union betwixt the auricle and ventricle,

which are in the fœtus (in the chick for example)

* The figure represents the osteum venosum and tricusped valve cut out. The stringy appearance is formed by the cordæ tendineæ, and the pendulous portions are the columnæ carneæ, which in their natural place are connected with the substance of the ventricle.

Sketch.

Representing the Backpart of the Heart – The great Coronary Vein
The Shape of the left Auricle – and the entrance of the Pulmonary Veins.



distinct bags; and from all the circle of this hole arises a membrane, thin, and apparently delicate, but really very strong; not divided into particular valves at this root or basis, but as the membrane hangs down into the ventricle, it grows thinner and is divided into fringes. How these fringes can do the office of valves is next to be explained. The tags and fringes of this membrane are actually tied to the inside of the ventricle by many strings, which being, like the valves, of a tendinous nature, are called CORDÆ TENDINEÆ, or tendinous cords; and these cords being attached to little processes projecting from the muscular substance of the heart, these processes are named COLUMNÆ CARNEÆ, or fleshy columns. Of these tyings of the valves there are three chief points; the whole circle seems to be divided into three sharp-pointed valves; they are named VALVULÆ TRICUSPIDES, or three pointed, or they are still sometimes called Triglochine Valves. The valves fall down easily when the blood goes down through them, and they rise readily and quickly whenever the blood gets behind them: when the ventricle is full, the valves are still open; but when the ventricle contracts, the blood throws up the valves, and closes the opening into the auricle; and now the tendinous cords and fleshy columns support the margins of the valves, so that they give them strength to support the heart's action.

6. The VENTRICLE of the RIGHT SIDE (II) is, like its auricle, larger than the same parts on the left side; for this auricle and ventricle of the right side have the weight of the whole blood of the body pressing upon them. They are subject to occasional fulness, for they must be dilated by many accidents, as labour, violent struggles, &c., which send the

blood too quickly upon the heart; while the left auricle and ventricle, on the other hand, can never be overloaded, as long as the pulmonic artery preserves its natural size, for that artery continues always the measure of the quantity of blood which they receive. The ventricle is thick, strong, fleshy. Its inner surface is extremely irregular; it puts out from every part of its surface very strong fleshy columns. These fleshy columns are irregular in size, big, strong, running along the length of the ventricle; some cross the ventricle, so as to connect its opposite walls together; some have the tendons of the valves fixed to them: all of them have perfect contractile power, and are, indeed, the strongest muscles of the heart. Betwixt the fleshy columns, there are, of course, very deep and irregular grooves; and among the confused roots of these fleshy columns the blood often coagulates, after death, into the form of what are called polypi of the heart. Yet still the walls of the right ventricle are thinner, the fleshy columns smaller, the cavity greater, than those of the left side; the right ventricle of the heart has also a peculiar form for the SEPTUM CORDIS, — a partition betwixt the right and left heart, is not, as generally supposed, a part common to both; but the left ventricle is longer and more conical than the right one; the septum belongs almost entirely to the left ventricle; the right ventricle, which is much bigger, laxer, flatter, and thinner, in the walls, is, as it were, wrapped round the left; and thus the left ventricle alone forms the acute apex of the heart, and the left ventricle of necessity bulges very much into the cavity of the right, since the right ventricle is so much larger, and in a manner wrapped round it. In both ventricles, it is very remarkable, that towards the opening of the auricle, the surface of the ventricle is very rugged, irregular, and crossed with columnæ carneæ, while a smooth and even lubricated channel leads towards the artery.

7. The PULMONIC ARTERY arises from the right ventricle, to carry out the blood close by the great

opening at which the auricle pours it in; the artery arises at its root in a very bulging triangular shape. It is the valves within the mouths of the artery that give it this very peculiar shape without; for the bulging root is divided into three knobs, indicating the places of the three valves, the artery dilating behind each valve into a little bag, which, when it is described, is called its sinus.

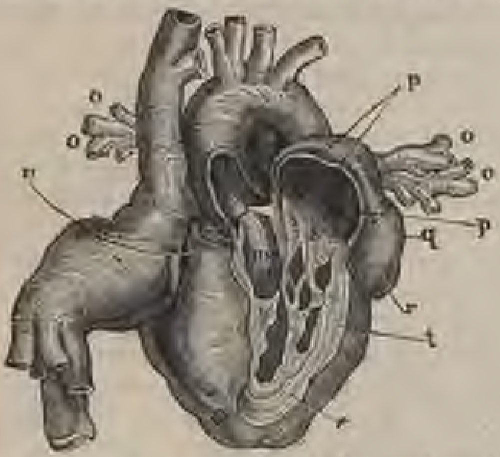
8. This VALVE of the PULMONIC ARTERY has a more perfect and simple form than that of the auricle. The valves in the mouth of each of the great arteries are three in number; they are thin but strong membranes, rising from the circle of the artery, where it comes off from the heart; each valve is semilunar; its larger and looser edge hangs free into the cavity of the artery; the edge is a little thicker than the rest of the valve; the three valves together form one perfect circle, which closes the mouth of the artery so that no grosser fluid, nor hardly air, can pass. When they are filled till they become very tense, each valve forms a kind of bag; so that when you look at the mouth of a dried artery, they appear like neat round bags; and when they are likely to be forced, the little horns or tags by which each valve is fixed into the coats of its artery, becomes so tense as to do the office of a ligament; these are called the SEMILUNAR OR SIGMOID VALVES.

Now, the condition of the ventricle while it is contracting is well understood: the auricle by its action lays down the tricuspid or auricular valve, and fills the ventricle; the ventricle cannot feel the stimulus of fulness till its valves rise, and its cordæ tendineæ begin to pull; and the ventricle could not be close for acting, nor its walls perfect, it could not in short be an entire cavity, till the tricuspid or auricular valves were completely raised. But there is another opening of the ventricle, viz. that into the artery, which must be also shut: this is one of the several instances of the subordination of these actions one to another; for, first, the auricle acts, then the ventricle, then the artery; so that the auricle and the artery are acting in the same moment of time; the

artery by acting throws down its valve, and closes that opening of the ventricle, while the auricle is filling it with blood: and again, the moment that the ventricle is filled, both the auricle and artery are in a state of relaxation; the auricular valve rises so as to close the ventricle on that side, and the arterial valve falls down, both because the artery has ceased acting, and because the valve is laid flat by the whole blood of the ventricle rushing through it. Hence it is very obvious, that the right ventricle could neither be filled nor stimulated, unless the opening toward the artery were closed during the time of its filling; and again it is obvious that this valve cannot be laid down by any other power than that of the artery itself: who then can doubt that the artery has in itself (like the ventricle) a strong contractile power? That it is the stroke of the artery succeeding that of the heart that lays down this valve so closely, is proved by this, that in many animals, in fishes, for example, the aorta is as plainly muscular as the heart itself,—it is like a second heart; and in fishes the vessel returning from the gills, and often in human monsters, the artery alone, by its own muscular power, moves the whole circulation without any communication with the heart. In fishes there is no second heart for the circulation of the body; and in monsters the heart is sometimes wanting, and there is found nothing but a strong aorta to supply its place. This stroke of the pulmonic artery, then, (which the heart excites,) pushes the blood through the lesser circle or circulation of the lungs, and by the pulmonic veins it is poured into the left side of the heart.

9. The LEFT AURICLE of the heart is unlike the right auricle in these respects: the sinus, or that part which consists of the dilatation of the pulmonic veins, is smaller; while the auricula, which is the more muscular part, is larger; the pulmonic veins come in five great trunks from the lungs, three from the right side and two from the left; these great veins then enter at each side of the left auricle, by which it gets a more square form; the whole of the left sinus, which forms the chief bulk of this part, is

turned directly backwards towards the spine, and is not to be seen in any common view of the heart; but I have here added a plate representing the back part of the heart*, showing, 1. How the left ventricle lies behind; 2. How the left auricle is turned still more directly backwards; 3. How the pulmonic veins enter into it in four great branches, so as to give a square or box-like form, compared with the gliding, gentle shape of the right auricle; 4. How the pulmonic artery comes out from under the arch of the aorta, dividing into its two great branches for each side of the lungs; and, 5. How the aorta arches over it, towers above all the other vessels, and is known always among the vessels of the heart by the carotid and subclavian arteries which come off from its arch.



On this plan are seen—(oo) the pulmonic veins entering from each side of the lungs—(pp) the opening of these into the auricle—(qq) the sinus formed

* Explanation of the BACK VIEW of the HEART, in the adjoining plate.
1. The left Ventricle—2. The left Auricle—3 3 3 3. The four pulmonic Veins—4 4. The two great branches of the Pulmonic Artery—5. the Aorta—6. The Carotids and Subclavians—7. The Cava Descendens—8. The Cava Ascendens, with all its branches from the Liver—9. The great Coronary Vein running along the back of the Heart betwixt the Auricle and Ventricle in a groove surrounded by fat.

in part by the dilatation of these veins, and,—(r) the auricula or little ear, from which the whole bag is named auricle.

10. The valves which guard the left auricle are seen here (ss):—Now, it is to be remembered that the left auricle is smaller than the right; that the circle or opening of the left auricle is of course smaller than that of the right; that while it requires a valve divided into three points to fill the opening of the right auricle, a valve divided only into two points suffices for the opening of the left auricle: this is the reason of this slight variety of shape betwixt the two auricular valves, and is also the reason of the valve of the right side being called TRICUSPID or three-pointed, while this of the left side, from some very slight resemblance to a mitre, is named VALVULA MITRALIS, the MITRAL VALVE. In all other points this valve is the same with that of the right side; it has the same apparent thinness, for it is even transparent; the same real strength; the same COLUMNÆ CARNEÆ and tendinous strings to support it; and the VENTRICLE (tt) has the same rough irregular surface towards the opening of the auricle; the same smooth gutter—(m) leading towards the artery. The constitution of all these parts, in short, is expressly the same; so that even concerning the left ventricle there is nothing further to be observed, but that while it is much longer than the right ventricle, it is much smaller in its whole cavity, is much stronger in its COLUMNÆ CARNEÆ, and much thicker in its fleshy walls; as at (tt) where it is seen to be thicker than the right ventricle, it is indeed nearly three times as thick.

11. The SEMILUNAR VALVES of the aorta are also seen in this general plan at (u)—where manifestly the general structure and general intention of the valves are the same as in those of the pulmonic artery; but still we find at every point marks of superior strength and more violent action in the left side of the heart; for though this valve be expressly like that of the pulmonic artery, and named like it, semilunar, yet it is thicker and stronger in its sub-

stance, and is peculiarly guarded by three small hard tubercles, which being placed one in the apex or point of each valve, meet together when the valve is close, and give a more perfect resistance to the blood, and prevent the valve being forced open. These are to be seen chiefly in the drawing, (p. 532) and from their being of the size of sesamum seeds, they have the name of CORPORA SESAMOIDEA; sometimes they are named Corpuscula Aurantii.

12. The AORTA arises from its ventricle very large and strong; it swells still more at its root than the pulmonic artery does; the three subdivisions of this swelling, which mark the places of the semilunar valves, are very remarkable; the curvature at the arch of the aorta is called its great sinus, and these three smaller bags are called the three lesser sinuses of the aorta.

OF THE CORONARY VESSELS.

But there still remains to be explained that peculiar circulation by which the heart itself is nourished; and yet there is nothing in it very different from the usual form of arteries and veins: it is a part of the general circulation of the body; for the heart is nourished by the two first branches which the aorta gives off. The circulation destined for the nourishment of the heart is peculiar in this chiefly, that the forms of the arteries and veins of the heart are beautiful, and that

the arteries rise just under the valves of the aorta, while the veins end with one great mouth in the right auricle. The coronary arteries are two in number, of the size of crow-quills; we see from the inside of the artery their mouths opening above the sigmoid valves. One artery comes from the lower side of the aorta; it lies towards the right; it belongs chiefly to the right ventricle; it comes out

first betwixt the roots of the aorta and pulmonic arteries; it passes in the furrow betwixt the right ventricle and auricle, and turning round arrives at the back part of the heart, and runs down along the middle of that flat surface which lies upon the diaphragm; and when it arrives at the apex of the heart, its extreme arteries turn round the point and inosculate with the opposite coronary. The other coronary belongs in like manner to the left side of the heart, and arises from the upper side of the aorta; it first goes out betwixt the pulmonic artery and the left auricle, and then turning downwards upon the heart, it runs along that groove which is betwixt the ventricles, and marks the place of the partition or septum ventriculorum; its chief branches turn towards the left ventricle, and branch out upon it; it belongs as peculiarly to the left side of the heart as the other does to the right side: after supplying the left ventricle, &c. it turns over the point of the heart to meet the extremity of the first, and inosculate with it. Both these arteries give branches not only to the flesh of the ventricles, but to the auricles, and also to the roots of the great arteries, constituting the VASA VASORUM, as such minute branches sent to vessels are called.*

* This is the aorta inverted, so as to show the semilunar valves.—(A) One of the valves—(B) Corpus sesamoideum—(C) Opening of the coronary artery.

The GREAT CORONARY VEIN which collects the blood of these arteries, arises in small branches all over the heart; these meet so as to form a trunk upon the fore part of the heart, where the septum or union of the ventricles is. While small, the veins accompany their respective arteries; but after the great trunk is formed, the vein takes its own peculiar route. When the trunk of the great coronary vein (accompanied by several lesser veins) arrives at the auricle, it runs in between the left auricle and left ventricle; it turns all round the back of the auricle till it gets to the right side of the heart; it lies in the deep groove betwixt the auricle and ventricle, surrounded with much fat; and having almost entirely encircled the heart, it discharges its blood into the right auricle, close by the entrance of the lower cava. The opening is very large; it lies just above the tendinous circle of the auricle, and it is guarded with a strong semilunar valve. This is the great coronary vein; all the veins which appear upon the heart are but branches of it; what are called the MIDDLE vein of the heart, the vein of the right auricle, the vena innominata, &c. are all but branches of the great coronary vein running along the right side or lower surface of the heart; if there were to be any marked distinction, it should be into the GREAT CORONARY VEIN belonging to the left side of the heart, and the VENA INNOMINATA belonging to the right side. But one thing more is to be observed, viz. that upon the inner surface of the right auricle may be seen many small oblique and very curious openings, which serve for the mouths of veins, while their obliquity performs the office of a valve. This name of coronary vessels is a very favourite one with anatomists, and is applied wherever vessels surround the parts which they belong to, however little this encircling may be like a crown; and it is thus that we have the coronary arteries of the stomach, coronary arteries of the lips, and coronary arteries of the heart. But these vessels of the heart are really very beautiful, and have some things very peculiar in

their circulation: first, with regard to the coronary arteries, they lie with their mouths under the sigmoid valves; or at least, in so equivocal a manner that their peculiar posture has given rise to violent disputes; viz. whether they be filled, like all other arteries, by the stroke of the heart, or whether they be covered by the valve so as to let the blood rush pass them during the action of the heart.

We see the opening of the coronary arteries* rather, as I imagine, under the valve; though Haller says they are above the valve, and that the highest point to which the margin of the valve reaches in very old men is below the opening of the coronary artery, and half way betwixt it and the bottom of the sinus or little bag behind the valve. But let this be as it may, if the condition of the aorta be considered, it will be found to make no difference; for though the valves rise and fall, are at one time fully opened, and at another time closely shut, still in both these conditions of the valve the aorta is as full as it can hold; its contraction instantaneously follows that of the heart, but its contraction is not, like that of the heart, such as to bring its sides to-

* Sketch of the arch of the aorta with the coronary arteries.

gether; on the contrary, the aorta is full when the heart strikes, the action of the heart distends it to the greatest degree, the aorta re-acts so as to free itself of this distension, but still it remains in some degree full of blood; else how could this, like every other artery, preserve always its form and apparent size?*

In this condition of matters, it is obvious that the coronary branches are on the same footing with all the other branches of the aortic system; that, like all the other arteries, they first feel the stimulus of fulness from the push of the heart, and along with it the stroke of the aorta.

Secondly, with regard to the coronary veins a dispute has arisen more violent than this: for it has been doubted whether the coronary veins, large as they are, do actually convey the whole of the blood which the coronary arteries give out. Vieussens believed that some of the coronary arteries opened directly into the cavities of the heart, without the interposition of veins. Thebesius, after him, believed that there were some shorter ways by which the blood was returned; not by a long circle into the right auricle, but directly into the ventricles of the heart. Vieussens, Thebesius, and others who belonged to their party, pretended to prove this fact by injections: but what doctrine is there which such clumsy anatomy and awkward injections may not be made to prove?- They used mercury, tepid water, and air; and they forced these, the most penetrating

* In this cut the aorta is opened at its origin, and the semilunar valves exhibited. The openings of the coronary arteries are seen above the margins of the valves.

of all injections, till they exuded upon the inner surface of the heart; but if they had fixed their tubes, not into the coronary artery, but into the aorta, and had proceeded to inspect, not the heart, but all the viscera of the body, they would have found their injections exuding from every surface; of the pleura and lungs; of the peritonæum and intestines; of the brain and dura mater; of the mouth and tongue; and universally through the cellular membrane of the whole body; but if any coarse injection, as tallow or wax, be used, following this natural course, it keeps within the arteries and veins, and if thin and well prepared, finds its way back to the auricle of the heart; but this injection also is extravasated, and is found in the cavities of the heart.

Du Verney was so far engaged in this question, that having an opportunity of dissecting the heart of an elephant, he tied up the coronary arteries and veins, washed and cleaned very thoroughly the cavities of the heart; and then tried, by squeezing, and all kinds of methods, to make that blood which was tied up in the coronary arteries and veins exude upon the inner surface of the heart, but with no effect.

On the present occasion, a theoretical answer happens to be as satisfactory as the most correct experiments: and it is this. If there really were to be formed (by disease, for example,) those numerous openings which Thebesius and Vieussens describe, then the blood flowing all by these shorter and easier passages, none could come to the great coronary vein; its office would be annihilated; and itself, contracting gradually, would soon cease to exist.

OF THE EUSTACHIAN VALVE.

There remains to be explained in the mechanism of the heart one point; and which I have separated from the others; not because it is the least important, but because it is the most difficult, and, if I may be allowed to say so, not yet thoroughly understood:

I mean the anatomy of the EUSTACHIAN VALVE; which, if it had been easily described, should have been first described; for it is a valve which lies in the mouth of the lower cava, just where that vein enters the right auricle of the heart. How imperfect a valve this is, how difficult to dissect or to explain, may easily be known from this, that Winslow was first incited to look for the valve by some hints in Sylvius: he was soon after fairly directed to it by finding it in the tables of Eustachius, which were then first found and published by Lancisi, after the author had been dead 150 years; and yet with all this assistance Winslow sought for it continually in vain, till at last he reflected, that by cutting the heart in its fore part, he must have always in his dissections destroyed any such valve. By opening the back part of the cava he at last saw the valve, and demonstrated it to the Academy of Sciences in France; and having just received from Lancisi his edition of the Eustachian Table, so long hidden, and since so outrageously praised, he called it VALVULA EUSTACHIANA, a name which it has retained to this day, and he added RETICULARIS, to express its lace-like netted appearance at its upper edge. From Winslow's time to this present day, that is, for eighty years, there has been no good drawing, nor even any perfect description of the valve; and in the confusion of opinions upon the subject, what its use may be no one knows.

The Eustachian valve lies in the mouth of the ascending cava, just where that great vein is joined to the auricle of the heart. It looks as if formed merely by the vein entering at an acute angle, and by the inner edge of the vein, or that which is joined to the auricle, rising high, so as to do the office of a valve. The very first appearance of the valve, and its place just over the mouth of the cava, seem to point out that use which Lancisi has assigned it, viz. to support the blood of the upper cava, and prevent that column of blood which descends from the cava gravitating upon the opposite column which comes

from the liver and lower parts of the body; and yet this, most likely, is not its use. The valve somewhat resembles a crescent, or the membrane called hymen. It occupies just that half of the cava which is nearest the auricle. Its deepest part hangs over the mouth of the cava, and is nearly half an inch in breadth, seldom more, often less, sometimes a mere line. Its two horns extend up along the sides of the auricle; the posterior horn arises from the left of the isthmus, as it is called, or edge of the oval hole; its anterior horn arises from the vena cava, where it joins the auricle. Behind the valve the remains of the foramen ovale may be seen, now shut by its thin membrane, but still very easily distinguished; for its arch-like edges are so thick, strong, and muscular, that they look like two pillars, and thence are called the COLUMNÆ FORAMINIS OVALIS. These two pillars were called ISTHMUS VIEUSSENII, and by Haller are named ANNULUS FOSSÆ OVALIS; while the remains of the hole itself is so deep that it is named the FOSSA OVALIS. Before the Eustachian valve lies the great opening into the ventricle; but betwixt that and the valve there is a fossa or hollow, in which lies the opening of the great coronary vein; and the valve which covers the coronary vein is a neat small slip of white and very delicate membrane, sometimes reticular, the one end of which connects itself with the fore part of the Eustachian valve; so that both valves are moved and made tense at once.

The Eustachian valve is in general thin and transparent; it is sometimes reticulated or net-like even in the fœtus, but by no means so often as to vindicate Winslow, in adding reticularis to the name; it grows reticulated chiefly in the adult. The only beautiful drawing that we have of a reticular Eustachian valve is in Cowper; and that was from a man of eighty years of age. Perhaps in eight or ten hearts you will not find one that is reticulated in the least degree; in old men it is reticulated, just as all the other valves of the heart are, not by any thing peculiar to the constitution of this valve,—not by the pressure of the blood and continual force of the vessels, as Haller represents,—but by the gradual absorption which goes on in old age, and which spares not the very bones, for even they grow thin, and in many places transparent.*

* This wood-cut represents the right auricle, opened to show the Eustachian valve, foramen ovale, and the mouth of the coronary vein.

This is the simple description of a valve, which has been the occasion of more controversy than the circulation of the fœtus and the use of the oval hole. Winslow first began about eighty years ago to observe the connections and uses of this valve: he laid it down as an absolute fact, that this valve was almost peculiar to the fœtus; that it was perfect only while the foramen ovale was open; that it vanished gradually as the foramen ovale closed; that in the adult it was seldom seen, unless the foramen ovale was also open by chance. It is incredible what numbers of anatomists followed this opinion; for the difficulty of dissecting the valve made it always easier to say that it was only in the fœtus that it could be found: it is also incredible what absurd consequences arose from this doctrine, which, after all, is but a dream; for in fact the valve is more easily shown in the adult heart.*

The foundation being now laid for connecting this valve with the peculiar circulation of the fœtus, they conceived the following theory, which has come down to this very day; viz. that in the child the great object of nature, in arranging its vessels, was to convey the blood which came fresh from the mother's system directly into the carotids, and so plump into the head at once. The pure blood from the mother comes through the liver by the ductus

* One author, I find in the Acta Vindobonensia, is exceedingly angry indeed with all the great anatomists, for not connecting more strictly with each other the anatomy and accidents of the foramen ovale and Eustachian valve; with Morgagni, Albinus, and Wiethrecht, he is offended for saying that they had seen the foramen ovale open, without saying one word concerning the state of this valve; and with Lieutaud, Portal, and others again, he is equally offended that they should have had opportunities of seeing the Eustachian valve entire without enquiring into the condition of the oval hole. The reason of all this is very plain; the oval hole had not been open, neither in the one situation nor in the other, else it is very unlikely that such correct and anxious anatomists should have described that valve which arises from one of the borders of the oval hole, without observing it open, if it was so; especially as the oval hole being open is by no means an usual occurrence.

venosus; it is deposited in the lower cava at the right side of the heart; and these anatomists supposed that this current of fresh blood was directed by the Eustachian valve into the oval hole, through that into the left auricle and ventricle, and from these directly into the aorta and carotids; while the foul blood of the upper cava went down into the right auricle and ventricle, and from that into the ductus arteriosus, and so away down to the lower and less noble parts of the body, and to the umbilical arteries, and so out of the system; for the ductus arteriosus, which comes from the right ventricle in the fœtus, joins the aorta only as it goes down the back, and none of its blood can pass upwards into the head.

This is the theory which, modified in various ways, has amused the French Academy, or, rather, been the cause of a perpetual civil war in it, for a hundred years. This doctrine began with Winslow; it is still acknowledged by Sabatier; and Haller, after announcing a theory not at all differing from this, challenges it as his own theory; "hanc meam conjecturam etiam a Nichols video proponi." Of the truth of this theory Haller was so entirely satisfied, that he not only published it as peculiarly his own, but reclaimed it when he thought it in danger of being thus appropriated by another. Sabatier is the last in this train of authors; and in order that there might remain no ambiguity in what they had said or meant, he pronounces plainly that the Eustachian valve is useful only in the fœtus, and that there are two opposite currents in the right auricle of the heart; that the one goes from the lower cava upwards to the foramen ovale, while the other from the upper cava descends right into the opening of the ventricle. What shall we say to anatomists who in the narrow circle of the auricle conceive two currents to cross each other directly, and to keep as clear of each other as the arrows by which such currents are usually represented? This error in reasoning is below all criticism; it carries us backwards a hun-

dred years in anatomy and in physics; and yet this is all that Winslow, Haller, Sabatier, and many others, have been able to say in proof of the connection of the Eustachian valve with the circulation of the fœtus.

Lancisi, again, believed that it was chiefly useful by supporting the blood of the lower cava, defending it from the weight of that column of blood which is continually descending from above; and Winslow and others approved of this, as being, perhaps, one use of the valve. But they have all of them forgotten a little circumstance, which must affect the office of the valve, and which should have been regarded, especially by those who said it was useful chiefly before birth; they have forgotten a little circumstance, which John Hunter also forgot, when theorising about the gubernaculum testis, viz. that the child lies with its head downmost for nine months in the mother's womb.*

Nothing is more certain than that the Eustachian valve is not peculiar to the fœtus; that it has no connection with the oval hole; that the valve is often particularly large after the foramen ovale is closed; that the valve is often obliterated where yet the foramen ovale remains open; that in adults it is more easily demonstrated than in children; that in old age it is often reticulated as the other valves are. Its use relates neither to the foramen ovale, nor to the ascending cava; it relates to the auricle itself, and, therefore, it is found in all the stages of life, smaller or larger, according to the size or form of the heart.

The auricle on the side towards the venæ cavæ is imperfect; the anterior part of the auricle chiefly is muscular, and when it contracts, the laxity of the

* I have left these opinions as originally expressed by Mr. John Bell, because I think it right that the reader should have the opinions fairly before him. In what follows he gives his own opinion of the function of this membrane. Notwithstanding all that is here delivered, I believe that the principal use of this membrane is to direct the blood during the fœtal circulation, and that it remains as a mere ligamentous bond, strengthening the auricle in the adult. C. B.

cavæ and the great width of the SINUS VENOSUS, *i. e.* of almost the whole auricle, would take away from its contraction all effect; but to prevent this, and to make the auricle perfect, the vena cava and auricle meet so obliquely, that the side of the cava makes a sort of wall for the auricle on that side. This wall has entirely and distinctly the reticulated structure of the auricle itself, with fleshy bands of muscular fibres in it. This wall falls loosely backwards when the auricle is quite relaxed, as, for example, when we lay it open; and thus it has got the appearance and name without the uses of a valve; but when the heart is entire, tense, and filled with blood, this valve represents truly a part of the side of the auricle: and that this part of the wall of the auricle should be occasionally a little higher or lower, looser or tenser, we need not be surprised. This further may be observed, that wherever, as in a child, this valve is very thin and delicate, the anterior part of the fossa ovalis goes round that side of the auricle particularly deep and strong. Let it also be remembered, that in certain animals this valve is particularly large and strong; now, in a creature which goes chiefly in a horizontal posture, it may strengthen and make up the walls of the auricle (the chief use which I have assigned for it in man); but surely it cannot protect the blood of the lower cava from the weight of blood coming from above, since the body of an animal lies horizontally, and there is no such weight. The Parisian academicians describe the heart of the Castor in the following terms: "Under the vena coronaria we find the valve called nobilis (viz. the Eustachian valve,) which fills the whole trunk of the vena cava, and which is so disposed that the blood may be easily carried from the liver to the heart by the vena cava, but which is hindered from descending from the heart towards the liver through the same vein."

OF THE IRRITABILITY AND ACTION OF THE HEART.

But even this curious mechanism of the heart is not more wonderful than its incessant action, which

is supported by the continual influx of stimulant blood, and by its high irritability and muscular power; for though we cannot directly trace the various courses of its muscular fibres, there is not in the human body any part in which the muscular substance is so dense and strong. In the heart there can be no direct or straight fibres; for let them go off from the basis of the heart in what direction they may, still, as they belong to the one or the other ventricle, they must, by following the course and shape of that ventricle, form an oblique line. Vesalius has, indeed, not represented them so: he has drawn straight fibres only; because in the latter end of his great work he was without human subjects, and betook himself to drawing from beasts.

The fibres of the heart are all oblique, or spiral, some lying almost transverse; they all arise from a sort of tendinous line which unites the auricle to the ventricle; they wind spirally down the surface till the fibres of the opposite ventricles meet in the septum and in the apex of the heart. The fibres of each ventricle pass over the convex or upper surface of the heart, then over the apex, and then ascend along the flat side of the heart, which lies upon the diaphragm, till they again reach the basis of the heart. The second layer or stratum of fibres is also oblique; yet many of the fibres run almost transversely, uniting the oblique fibres; but when we go down into the thick substance of the heart, we find its fibres all mixed, crossed, and reticulated in a most surprising manner; so that we at once perceive, both that it is the strongest muscle in the body, and that the attempt to extricate its fibres is quite absurd.* Their desire of giving more correct and regular descriptions has been the cause why those who have particularly studied this point have been fatigued and disappointed: the most sensible of them have acknowledged, with Vesalius, Albinus, and Haller,

* Thickening the walls of the heart by vinegar, strong acids, alum, or boiling the heart, have assisted us in unravelling its structure but very little.

that the thing could not be done; while those, again, who pretended to particular accuracy, and who have drawn the fibres of the heart, have represented to us such extravagant, gross, and preposterous things, as have satisfied us more than their most ingenuous acknowledgments could have done, that they also could accomplish nothing.

There is no question that irritability is variously bestowed in various creatures; that it is variously appointed in various parts of the body; that this property rises and falls in disease and health: without hesitation we also may pronounce that the heart is in all creatures the most irritable part; it is the part first to live and the last to die: "Pulsus et vita pari ambulant passu." When we see the punctum saliens in the chick, we know that there is life; and when we open the body of an animal soon after death, still the heart is irritable and contracts.

In the very first days in which the heart appears in the chick, while yet its parts are not distinguished, and the punctum saliens is the only name we can give it, the heart, even in this state, feels the slightest change of heat or cold: it is roused by heat; it languishes when cold; it is excited when heated again. It is stimulated by sharp points or acids; it works under such stimuli with a violent and perturbed motion. In all creatures it survives for a long while the death of the body; for when the creature has died, and the breathing and pulse have long ceased, and the body is cold, when the other muscles of the body are rigid, when the stomach has ceased to feel, when the bowels, which preserve their contractile power the longest, have ceased to roll, and they also feel stimuli no more, still the heart preserves its irritability; it preserves it when torn from the body and laid out upon the table; heat, caustics, sharp points, excite it to move again.

We know also another thing very peculiar concerning the irritability of this organ, viz. that it is more irritable on its internal than on its external surface; for if instead of cutting out the heart we

leave it connected with the body, seek out (as the old anatomists were wont to do) the thoracic duct, or pierce any great vein, and blow a bubble of air into the heart, it pursues it from auricle to ventricle, and from ventricle to auricle again, till, wearied and exhausted with this alternate action, it ceases at last, but still new stimuli will renew its force.

Thus it is long after apparent drowning or other suffocation before the principle of life is gone, and long after the death of the body before the heart be dead; and just as in this peculiar part of the system irritability is in high proportion, there are in the scale of existence certain animals endowed in a wonderful degree with this principle of life. They are chiefly the amphibious creatures, as they are called, needing little air, which have this power of retaining life; no stimuli seem to exhaust them; there seems especially to be no end to the action of their heart. A Newt's or a Toad's heart beats for days after the creature dies. A Frog, while used in experiments, is often neglected and forgotten, its limbs maugled, and its head gone, perhaps its spinal marrow cut across, and yet for a whole night and a day its heart does not cease beating, and continues obedient to stimuli for a still longer time. It seems as if nothing but the loss of organization could make this irritable muscle cease to act; or rather it seems as if even some degree of deranged organization could be restored: breathe upon a heart which has ceased to act, and even that gentle degree of heat and moisture will restore its action. Dr. Gardiner having left a turtle's heart neglected in a handkerchief, he found it quite dry and shrivelled, but by soaking it in tepid water its plumpness and contractility were restored.

Although the ancients knew how irritable the heart was,—although they often opened living creatures, and saw the heart struggling to relieve itself, because it was oppressed with blood,—yet they continued entirely ignorant of the cause; and why the heart should alternately contract and relax without stop or interruption seemed to them the most inexplicable

thing in nature. Hippocrates ascribed it to the innate fire that is in the heart; Sylvius said, that the old and alkaline blood in the heart mixing with the new and acid chyle, and with the pancreatic lymph, produced a ferment there; Swammerdam, Pitcairn, and Friend, thought that the heart, and every muscle which had no antagonist muscle, was moved by a less proportion of the vital spirit than other muscles required. Others believed that each contraction of a muscle compressed the nerves of that muscle, and each relaxation relieved it; and that this alternate compression and relief of the nerve was the cause of the alternate movements of the heart. Another physician of our own country, a great mechanic, and a profound scholar in mathematics, and all those parts of science which have nothing to do with the philosophy of the human body, refined upon this theory most elegantly; for observing that the nerves of the heart turned round the aorta, and passed down betwixt it and the pulmonic artery, he explained the matter thus: "These great arteries, every time they are full, will compress the nerves of the heart, and so stop this nervous fluid, and every time they are emptied (a thing which he chose to take for granted, for in truth they never are emptied,) they must leave the nerves free, and let the nervous fluid pass down to move the heart."

Descartes, who studied every thing like a right philosopher of the old breed, viz. by conjecture alone, supposed that a small quantity of blood remained in the ventricle after each stroke of the heart; which drop of blood fermented, became a sort of leaven, and operated upon the next blood that came into the heart, "like vitriol upon tartar;" so that every successive drop of blood which fell into the ventricle swelled and puffed up so suddenly as to distend the heart, and then burst out by the aorta. Philosophers have been so bewitched with the desire of explaining the phenomena of the human body, but without diligence enough to study its structure, that from Aristotle to Buffon it is all the same, great ignorance and great presumption. But on this sub-

ject of the pulse of the heart, physicians almost surpassed the philosophers in the absurdity of their theories, till at last they were reduced to the sad dilemma of either giving up speaking upon this favourite subject, or of contenting themselves with saying, "that the heart beat by its facultas pulsifica, its pulsative faculty."

The ancients, I have said, often opened living creatures, and saw the heart struggling to relieve itself because it was oppressed with blood: this blood is itself the stimulus which moves the whole; for important as this function is, it is equally simple with all the others: and as urine is the stimulus to the bladder, food an excitement to the intestines, and the full grown fœtus a stimulus to the womb;—so is blood the true stimulus to the heart. When the blood rushes into the heart, the heart is excited and acts; when it has expelled that blood, it lies quiescent for a time; when blood rushes in anew, it is roused again: so natural is both the incessant action and regular alternation of contraction and relaxation in the heart.

It is when we are so cruel as to open a living creature that we see best both the operation of the blood as a stimulus, and the manner in which the heart reacts upon it. When we tie the two venæ cavæ so as to prevent the blood from arriving at the heart, the heart stops; when we slacken our ligatures and let in the blood, it moves again; when we tie the aorta, the left ventricle being full of blood will continue struggling, bending, turning up its apex, and contracting incessantly and strongly, and will continue this struggle long after the other parts have lost their powers. One author, whether from his awkwardness, or the delicacy of the subject, or really from the strength of the ventricle, assures us, that often while he has held the aorta of a frog close with pincers, it has burst by the mere force of the heart. If, after violent struggles of this kind, you cut the aorta, even of so small a creature as an eel, it will throw its blood to the distance of three or four inches.

Thus we not only know that we can excite the

heart by accumulating blood in it, but that by confining the blood in it we can carry that excitement to a very high degree. But to understand what authors have greatly puzzled themselves about, we must remember that the blood performs a double office. It is, as arterial blood in the coronary circulation, the source of the heart's irritability; whilst, as dilating the cavities, it is the excitement to that irritability.

There is another circumstance of some moment in comprehending this. The irritability of the heart is not like that in a common voluntary muscle; every muscle has its law of action; and although the heart appears to be, and indeed is, regulated in the velocity of its action by the rapidity of its supply with blood, yet if torn out of the body it will continue pulsating, and the alternate action of auricle and ventricle may be seen although there be no blood to propel. This points out the admirable manner in which the vital property is accommodated to the particular function, —how the mechanical and vital provisions are made to correspond.

With all this we can readily understand that the dilatation by the blood is the proper stimulus to the heart's action, and that distention is a more powerful cause of action than pricking it. Stimuli applied outwardly make it contract partially; it trembles in particular fibres: but it is only letting in the blood, or blowing it up with air, that can bring it into full action again. When we look with cruel deliberation upon the strokes of the heart in any living creature, we observe that at first, during the full and rapid action of the heart, there is hardly any perceptible interval among the several parts; but towards the end of each experiment, when the pulse flags, and the creature falls low, the swelling of the great veins, and the successive strokes of auricle and ventricle, are distinctly told. The dilatation and contraction of each part is what we cannot observe, they are so quick; but these things we distinctly observe — the auricle contracts and dilates the ventricle; the ventricle contracts, subsides, and fills the aorta; the aorta turns and twists with the force of the blood

driven into it, and by its re-action; and the ventricle, every time that it contracts, assumes a form slightly curved, the point turning up like a tongue towards the basis, and the basis in some degree bending towards the point. The basis, indeed, is in some degree fixed to the diaphragm and spine, but the heart in its contraction always moves upon its basis as upon a centre; its ventricles, and especially its apex, are free; the point rises and curves so as to strike against the ribs; and the dilatation of the heart is such (together with the posture and relation of its several parts), that during the dilatation the heart turns upon its axis one way; the contraction of the heart reverses this, and makes it turn the other way, so that it seems to work perpetually with the turning motions of a screw. All this is most striking, while we are looking upon the motion of the heart in a living creature.*

The posture of the human heart is very singular, and will illustrate this turning motion extremely well; for in the human heart the posture is so distorted, that no one part has that relation to another which we should beforehand expect. In the general system, the human heart is placed nearly in the centre, but not for those reasons which Dionis has assigned; it is not in order that by being in the

* We find this explanation of the beating of the heart against the ribs by Dr. William Hunter. "The systole and diastole of the heart, simply, could not produce such an effect; nor could it have been produced, if it had thrown the blood into a straight tube, in the direction of the axis of the left ventricle, as is the case with fish and some other classes of animals; but by throwing the blood into a curved tube, viz. the aorta, that artery, at its curve, endeavours to throw itself into a straight line, to increase its capacity; but the aorta being the fixed point against the back, and the heart in some degree loose and pendulous, the influence of its own action is thrown upon itself, and it is tilted forwards against the inside of the chest." — See note to John Hunter's Treatise on the Blood, p. 146.

It must be remembered, that the right ventricle throws its blood into the pulmonary artery at the same instant that the left propels its blood into the aorta, and the tendency to tilt up the apex of the heart must, therefore, belong to both arteries. The blood is also accumulating in both the auricles at the moment the arteries are thus filled, which is an additional cause of the point of the heart rising.

centre it may feel less the difficulty of driving the blood to any particular limb or part of the body; it is the place of the lungs that regulates the posture of the heart; and wherever they are, it is. Except the Oyster, I hardly know of any creature in which the heart lies expressly in the centre of the body. In Frogs, Toads, Newts, and Snakes, the lungs are not moved by any diaphragm: they are filled only by the working of the bag attached to the lower jaw, the lungs in them being under the jaws, and the heart is lodged at the root of the jaws, leaving, as in a Newt or Cameleon, Crocodile, Adder, Serpent, &c. the whole length of their trailing body behind. In a fish, the gills serve the creature for lungs: the gills are lodged under the jaws, and the heart is placed betwixt them. In insects, as in the common Caterpillar, (the aurelia of our common Butterfly,) the air enters by many pores on its sides; and accordingly its heart is not a small round bag, but may be easily seen running all down its back, working like a long aorta, but having regular pulsations, denoting it to be the heart: and this you easily see through the insect's skin, for it is more transparent along the back where the heart is.

The breast in man is divided into two cavities by a membrane named the MEDIASTINUM. This mem-

brane passes directly across the breast from the sternum before till it fixes itself into the spine behind. It is on the left side of this membrane, in the left cavity of the breast, that the heart is placed, lying out flat upon the diaphragm, as upon a floor, by which it is supported: and that surface (*a*), which lies thus upon the diaphragm, is perfectly flat, while the upper surface (*c*), or what we usually call the fore part of the heart, is remarkably round. The whole heart lies out flat upon the diaphragm; its basis, where the auricles are, is turned towards the spine and towards the right side; the apex (*d*), or acute point, is turned forwards and a little obliquely towards the left side, where it strikes the ribs; the vena cava (*e*) enters in such a manner through a tendinous ring of the diaphragm* that it ties down the right auricle to that floor (as I may term it) of the thorax. The aorta (*f*) does not rise in that towering fashion in which it is seen when we take a dried-up heart, which naturally we hold by its apex, instead of laying it out flat upon the palm of our hand; nor in that perpendicular direction in which hitherto, for the sake of distinctness, I have represented it in these plans; but the aorta goes out from its ventricle towards the right side of the thorax; it then turns in form of an arch, not directly upwards, but rather backwards, towards the spine; then it makes a third twist to turn downwards; where it turns downwards it hooks round the pulmonic artery (*g*), just as we hook the fore fingers of our two hands within one another; and from the bifurcation of the pulmonic artery there goes off a ligament to the aorta, which is the remains of the ductus arteriosus, to be afterwards described. The right heart (*h*) stands so before the other, that we see chiefly the right auricle and ventricle before, so that it might be named the anterior heart; the pul-

* Let it be observed, that (*e*) in this drawing marks the point where the lower cava was tied close upon the diaphragm, to prevent the injection going down into the veins of the liver and abdominal cavæ.

monic artery (g) covers the root of the aorta; the left ventricle (i), from which the aorta rises, shows little more than its point at the apex of the heart; the left auricle (k) is seen only in its very tip or extremity, where it lies just behind the pulmonic artery; and the aorta (f) arises from the very centre of the heart. From this view any man may understand these vessels by other marks than the mere colours of an injection; and he will also easily understand why the heart twists so in its actions, and how it comes to pass that its posture is difficult for us to conceive, no one part having that relation to any other part which we should beforehand suppose.

OF THE PERICARDIUM.*

But the PERICARDIUM, purse, or capsule, in which the heart is contained, affects and regulates its posture, and makes the last important point concerning the anatomy of the heart. It is a bag of consider-

* PLAN OF THE PERICARDIUM. — (a) Outside of the pericardium — (b) part where the membrane is reflected on the heart — (c) the same membrane covering the substance of the ventricle. N. B. — The membrane, which is extremely thin, is represented thick and coarse, for the sake of illustration.

able size and great strength, which seems to us to go very loosely round the heart, because when we open the pericardium the heart is quite empty and relaxed; but I believe it to surround the heart so closely as to support it in its palpitations, and more violent and irregular actions; for when we inject the heart, its pericardium remaining entire, that bag is filled so full that we can hardly lay it open with a probe and lancet without wounding the heart; and still further, when we open the pericardium before we inject the heart, the heart receives much more injection, swells to an unnatural bulk for the thorax that it is contained in, and loses its right shape. The pericardium is formed, like the pleura and mediastinum, of the cellular substance; it is rough and irregular without, and fleecy, with the threads of cellular substance, by which it is connected with all the surrounding parts; within it is smooth, white, tendinous, and glistening, and exceedingly strong. As the heart lies upon the floor of the diaphragm, the pericardium, which lies under the heart, is connected with the diaphragm a little to the left of its tendinous centre, and so very strongly that they are absolutely inseparable. The pericardium surrounds the whole heart, but it is loose everywhere except at the base of the heart, where it is connected with the great vessels: for the pericardium is not fixed into the heart itself, but rises a considerable way upon the great vessels, and gives to the roots of the vessels, which are seen on opening the pericardium, an outward coat, and surrounds each vessel with a sort of ring. For, 1st, It surrounds the pulmonic veins where they are entering the heart; there the pericardium is short: 2dly, It mounts higher upon the vena cava than upon any other vessel: the cava of course is longer within the pericardium, and it also is surrounded with a sort of ring: 3dly, It then passes round the aorta and pulmonic artery, surrounding these in one greater loop: 4thly, The cava inferior is the vessel which is the shortest within the pericardium; for the heart inclines towards the horizontal

direction; it lies in a manner flat upon the upper surface of the diaphragm, while the lower surface of the diaphragm adheres to the upper surface of the liver. Thus it happens that the liver and the right auricle of the heart are almost in contact, the diaphragm only intervening; thence the lower cava which passes from the liver into the right auricle of the heart cannot have any length. While the pericardium thus passes round the great vessels, it must leave tucks and corners; and these have been named the CORNUA, or horns of the pericardium.

But there is another peculiarity in the form of the pericardium, which I have explained in this second plan*; viz. that the pericardium constitutes also the immediate coat of the heart; for the pericardium having gone up beyond the basis of the heart so as to surround the great vessels, it descends again along the same vessels, and from the vessels goes over the heart itself. I have marked the manner of this more delicate inflection of the pericardum at (*aa*), where the pericardium is loose; at (*bb*), the angle where it is reflected; and at (*cc*), where it forms the proper coat of the heart, and where it is intimately united to its substance. The pericardium, where it forms this coat, becomes extremely thin and delicate, almost cuticular, but strong; under this coat the coronary arteries pass along in the cellular substance; under it the fat is gathered sometimes in a wonderful degree, so as to leave very little to be seen of the dark or muscular colour of the heart.

The pericardium, then, is a dense and very strong membrane, which I would compare with the capsule of any great joint, both in office and in form; for it is rough and cellular without, shining and tendinous within; bedewed with a sort of halitus like the great joints: its uses are to keep the heart easy and lubricated by that exhalation which proceeds from its exhalent arteries (and which can be imitated so easily by injecting tepid water into its arteries); to suspend

* See p. 553.

the heart in some degree by its connections with other parts, especially by its connections with the mediastinum and diaphragm. The pericardium limits the distention of the heart, and checks its too violent actions; just as we see it prevent too much of our injections from entering the heart. How strong the pericardium is, and how capable of supporting the action of the heart, even after the most terrible accidents, we know from this, that the heart or coronary arteries have actually burst, but with a hole so small as not to occasion immediate loss of life; then the pericardium, receiving the blood which came from the rupture, has dilated in such a manner as to receive a large quantity of blood, but has yielded so slowly as to support the heart in some kind of action, and so preserved life for two or three days. But while, according to authors, we have been following the inflection of the pericardium, we should not omit noticing that the membrane is double, and that, while the finer layer of the membrane is reflected over the heart, a stronger texture of fibres is sent off into the sheaths of the great vessels which ascend from the heart.

If I have not mentioned any fluid under the direct name of AQUA PERICARDII, or the water of the pericardium, it is because I consider the accident of water being found as belonging not to the healthy structure, but to disease. Yet this same water occupied the attention of the older authors in a most ludicrous degree. Hippocrates believed that this water of the pericardium came chiefly from the drink we swallow, which found some way or other (as it passed by the pericardium) to insinuate itself into this bag. Some after him said, it was the fat of the heart melted down by incessant motion and the heat of the heart; some said it was from humours exuding through the heart itself, and retained by the density of the pericardium, that this water came; and it is but a few years since this clear and distinct account of it was given, viz. "that it proceeds from the aqueous excrementitious humour of the third concoc-

tion." The same men, "viri graves et docti*," declare to us that the uses of the aqua pericardii are to cool the heart, for it is the very hottest thing in the body; or by its acrimony to irritate the heart, and support its motions; or to make the heart by swimming in it seem lighter. By this it is pretty obvious what absurd notions they had of the quantity of water that may be found in the pericardium. But of all the outrages against common sense and common decorum, the most singular was the dispute maintained among them, whether it was or was not the water of the pericardium which rushed out when our Saviour's side was pierced with a spear? The celebrated Bardius, in a learned letter to Bartholine, shows how it was the water of the pericardium that flowed out; but Bartholine, in his replication thereunto, demonstrates, that it must have been the water of the pleura alone. This abominable and ludicrous question, I say, they bandied about like boys rather than men: Bartholinus, Arius, Montanus, Bertinus Nicelius, Fardovius, Laurenbergius, Chiprianus, with numberless other Doctors and Saints, were all busy in the dispute; for which they must have been burnt every soul of them, at the stake, had they done this in ridicule; but they proceeded in this matter with the most serious intentions in the world, and with the utmost gravity. The whole truth concerning water in the pericardium is, that you find water there whenever at any time you find it in any of the other cavities of the body. If a person have laboured under a continued weakness, or have been long diseased; if a person have lain long on his death-bed, then you find water in the pericardium. But if you open any living animal, as a dog, or if you open the body of a suicide, not a drop of water will be found in the pericardium. When such fluid is to be found, it is of the same nature with the dropsical fluids of other cavities: in the child, and in young people, it is reddish, especially if the peri-

* They are thus denominated in all the charters of the College of Physicians from the time of Henry VIII, downwards.

cardium be inflamed; in older people, it is pellucid, or of a light straw colour; in old age, and in the larger animals, it is thicker, and more directly resembles the liquor of a joint.

Thus does the pericardium contribute in some degree to settle the posture of the heart; but still the heart is to a certain degree loose and free. It is fixed by nothing but its great vessels as they run up towards the neck, or are connected with the spine; but how slight this hold is, how much the heart must be moved, and these vessels endangered, by shocks and falls, it is awful to think. The pericardium is no doubt some restraint; its connections with the diaphragm and with the mediastinum make it a provision, in some degree, against any violent shock; its internal lubricity is, at the same time, a means of making the heart's motions more free: yet the heart rolls about in the thorax; we turn to our left side in bed, and it beats there; we turn over to our right side, and the heart falls back into the chest, so that its pulse is no where to be perceived; we incline to our left side again, and it beats quick and strong. The heart is raised by a full stomach, and is pushed upwards in dropsy: and during pregnancy its posture is remarkably changed; it is suddenly depressed again when the child is delivered, or the waters of a dropsy drawn off. It is shaken by coughing, laughing, sneezing, and every violent effort of the thorax. By matter collected within the thorax it may be displaced to any degree. Dr. Farquharson cured a fine boy, about eight years old, of a great collection of matter in the chest, whose heart was so displaced by a vast quantity (no less than four pounds) of pus, that it beat strongly on the right side of the breast while his disease continued, and as soon as the pus was evacuated, the beating of the heart returned naturally to the left side. Who could have believed that, without material injury, the heart could be so long and so violently displaced? Felix Platerus tells us a thing not so easily believed, that a young boy, the son of a printer, having practised too much that

trick which boys have of going upon their hands with their head to the ground, began to feel terrible palpitations in the left breast; these gradually increased till he fell into a dropsy from weakness, and died; and upon dissecting his body, the situation of his heart was found to have been remarkably changed by this irregular posture. Now, we are not to argue that such change of posture of the heart could not happen merely from this cause, because professed tumblers have not these diseases of the heart; it were as silly to argue thus against the authority of Platerus, as to say that every post-boy has not aneurisms of the ham, or that every chimney-sweeper has not a cancer of the scrotum.

We may now close this account of the mechanism of the heart; in which all the parts have been successively explained. We know how the heart is suspended by the mediastinum, and by its great vessels; how it is lubricated, supported, and regulated in its motions, by the pericardium: its nerves, which remain to be explained at a fitter time, are extremely small; while its vis insita, or irritability, is great beyond that of all the other parts. We can easily follow the circle of the blood, which, as it arrives from all the extremities, irritates the auricle, is driven down into the ventricle, is forced thence into the pulmonic artery, pervades the lungs, and then comes round to the left side of the heart, or to that heart which supplies the body; and there begins a new circulation, called the greater circulation, viz. of the body, as the other is called the lesser circulation of the lungs. Thus we recognise distinctly the functions of the double heart, with all its mechanism; the stronger heart to serve the body, the weaker heart to serve the lungs; and we see in the plainest manner two distinct functions performed by one compound heart: the right heart circulates the blood in the lungs, where it is purified and renewed; the left delivers out a quantity of blood, not such as to fill all the vessels, nor such as to move onwards by this single stroke of the

heart to the very extremities of the body, but such merely as to give a sense of fulness and tension to the vessels: the force is merely such as to excite and support that action which the arteries everywhere perform in the various organs of the body, each artery for its appropriated purposes, and each in its peculiar degree.

By understanding thus the true mechanism and uses of the heart, we can conceive how the ancients were led into strange mistakes by very simple and natural appearances. We understand why Galen called the right auricle the "ultimum moriens," or the part which died last; for, upon opening the body soon after death, he found the right auricle filled with blood, and still palpitating with the remains of life, when all the other parts seemed absolutely dead; and if the blood always accumulates on the right side of the heart before death, it is plain that the stimulus of that blood will preserve the remains of life in the right side, after all appearance of life on the left side is gone. But the cause of this accumulation of blood in the right side is very ill explained by Haller, though it seems to have employed his thoughts during half his life. He says, that in our last moments we breathe with difficulty; the lungs at last collapse, and cease to act; and when they are collapsed, no blood can pass through them, but must accumulate in the right side of the heart. That there is really no such collapse of the lungs, I propose hereafter to show; but, in the meanwhile, this is the true reason, viz. that when the ventricles of the heart cease to act, and the beating of the heart subsides, the two auricles lie equally quiet, but in very different conditions; the right auricle has behind it all the blood of the body pouring in from all parts during the last struggles; but the left auricle has behind it nothing but the empty veins of the lungs; nothing can fill it but what fills the vessels of the lungs; or in other terms, nothing can fill the left auricle but the stroke of the heart itself: but instead of acting the heart falls into a quiescent state;

the left auricle remains empty, while the blood oozes into the right auricle from all the extremities of the body till it fills it up.

Nothing is more agreeable than to find such phenomena described faithfully long before the reason of them is understood. In the Parisian Dissections I find the following description: "When the breast of a living Dog is opened by taking away the sternum, with the cartilaginous appendices of the ribs, the lungs are observed suddenly to sink, and afterwards the circulation of the blood and the motion of the heart to cease. In a little time after the right ventricle of the heart and the vena cava are swelled, as if they were ready to burst."* This was what deceived the ancients, and was the cause of all their mistakes. When they found the right ventricle thus full of blood, they conceived that it alone conveyed the blood; they found the left ventricle empty, and believed that it contained nothing but vital spirits and air; and so far were they from having any notions of a circulation, that they thought the air and vital spirits went continually forwards in the arteries; that the gross blood which was prepared in the liver came up to the heart to be perfected, and went continually forwards in the veins; or, if they provided any way of return for these two fluids, it was by supposing that the blood and spirits moved forwards during the day-time, and backwards in the same vessels during the night.

These things next explain to us why they called the right ventricle VENTRICULUS SANGUINEUS; they found it full of blood, and thought its walls were thinner, because it had only to contain the very grossest parts of the blood: and why they called the left ventricle VENTRICULUS SPIRITUOSUS and NOBILIS, because they saw it empty, and concluded that it contained the animal spirits and aërial parts of the blood, and its walls were thicker, they said, to contain these subtile spirits. They explain to us their names of ARTERIA VENOSA; and VENA ARTERIOSA;

* Page 261.

for they would have veins only on the right side of the heart, and arteries only on the left; and although they saw plainly that the pulmonic artery was an artery, they called it Arteria Venosa: and although, on the left side again, they saw plainly that the pulmonic vein was merely a vein, they would still cheat themselves with a name, and call it Vena Arteriosa: the veins, they said, were quiet, because they contained nothing but mere blood; the arteries leaped, they said, because they were full of the animal spirits and vital air.

The very name and distinction of arteries which we now use, arise from this foolish doctrine about air and animal spirits. To the oldest physicians there was no vessel known by the name of artery, except the ASPERA ARTERIA; and it was named Artery because it contained air; so that Hippocrates, when he speaks of the carotids, never names them arteries, but calls them the Leaping Veins of the neck. But when Eristratus had established his doctrine about the vessels which go out from the heart, carrying vital spirits and air, the name of artery was transferred to them; and then it was that the ancients began to call the vessels going out from the left side of the heart arteries, naming the aorta the ARTERIA MAGNA, and the pulmonic vein the ARTERIA VENOSA.

When a vein was cut, they saw nothing but gross blood, and of a darker colour; but when an artery was cut, they observed that the blood was red; that it was full of air bubbles; that it spurted out, and was full of animal spirits; and thus it became easy for them to show how safe it was to open a vein where nothing was lost but gross blood, how terribly dangerous it was to open an artery, which was beating with the spirit of life; and this they considered as such an awful difference, that when arteriotomy in the temple was first proposed, they pronounced it murderous, and on this reasoning it was absolutely forsaken for many ages.

But the oldest of our modern physicians soon

found a necessity of mixing this blood and animal spirits together, and for a long while could hit on no convenient way by which this mixture might be effected: as a last shift, they made the blood exude through the septum of the heart: and then the current doctrine was, that of the blood which came from the liver, one half went into the pulmonic artery to nourish the lungs; the other half exuded through the septum of the heart, to mix with the animal spirits. Riolanus was the bitter enemy of Harvey and of his noble doctrine; and this is the miserable and confused notion, not to call it a doctrine, which he trumpeted through Europe in letters and pamphlets. To make good this miserable hypothesis, Riolanus, Gassendus, and many others, saw the necessity of having side passages through the septum of the heart. I really believe, from their mean equivocating manner of talking about these passages, that they had never believed them themselves.* "The chyle," says Bartholine, "and the thinner blood, pass through the septum of the heart, when the heart is in systole and the pores and passages are enlarged." Thus did the celebrated Bartholine believe the septum perforated. Wallæus, and Marchetti, and Mollinettus and Monichen, believed it, and Mr. Broadbecquius of Tubingen proved it.† But I believe most potently with Haller, that whenever they wanted to show those perforations, they managed their probes so as to make passages as wide and as frequent as the occasion required: "Solebant foramina parare adigendo stylos argenteos in resistens septum," says Haller; and this is a full and true account of all the authors who have described side passages through the septum of the heart; they needed them, and they made them.

Amidst all this ignorance, we cannot wonder that

* That I may not seem to speak too harshly of this knot of conspirators against Harvey, I will quote what Boerhaave says of Riolanus, who was at the head of them: Non ipse callidus cavillationum artifex Riolanus," &c.

† Experimento perforatum ostendit Broadbecquius Tubingæ.

a thousand childish imaginations prevailed, nor that the qualities of the mind were deduced from the physical properties of the heart. We have heard the vulgar, for example, speak of the bone of the heart. And from whom did this arise? From Aristotle! who explains to us, that there is at the root of the heart a bone which serves for its basis; and not a physician has written upon the heart since his time, who has not spoken more or less mysteriously about this bone; while in truth the whole story means nothing more than this, that where the basis of the arteries are fixed into the hard ring or basis of the heart, the place is extremely firm, almost cartilaginous, especially in old age, when often the roots of the arteries are ossified or converted into what anatomists have chosen to call bone.

Often, also, we have heard the vulgar talk, not figuratively, but in the plain sense of the words, of a little or big heart, as synonymous with a timorous or courageous heart. But whenever we hear mistakes of this kind among the vulgar, we may be assured they have some time or other come from high authority. Bartholine was so much convinced that a small heart begot courage, and a great one irresolution and fear, that he is thoroughly surprised when he finds the contrary: "Cor vastus fuit homo, tamen audax fuerat, ut cicatrices in capite frequentes et rimæ in cranio testabantur." But if Bartholine be right, Kirkringius is quite wrong, and has mistaken the doctrine; for he says, "An magnanima fuerit hæc magni cordis fœmina, nescio," &c. "I do not know whether this woman's courage was as big as her heart; but this I do know, that she was a famous toper. Whether this drinking dilates the heart, and makes your staunch drinkers such famous fighters, I cannot pretend to decide." We have heard the vulgar talk also of a hairy heart, as familiarly as of a hairy man, being the mark of high courage and strength: but what shall we think of it, when we find that this report is to be deduced fairly from Pliny, through the most celebrated names among

our old physicians? He it was who began with telling how the Messenians, that unhappy people, who lived for so many ages the slaves or helots of Greece, lost their great general, Aristomenes. But how great he was, never, according to Pliny, came to be known till after his death; for the Lacedemonians having catched him three times, resolved at last to open his breast; and there, as a proof of his most invincible courage and daring, they found his heart filled with hair. This from Pliny was nothing, if such dissections had not been made since then a hundred times. "There was a robber, (says Benivinius,) one Jacobus, who having been taken down from the gibbet apparently dead, but really having in him the remains of life, was laid out carefully, recovered, was perfectly restored, betook himself to his old ways again; and so in the natural course of things came round to his old mark, the gallows, and was this time very thoroughly hanged. Wondering (says Benivinius) at the perfect wickedness of this man, I longed very anxiously to dissect the body; and I actually found the heart, not covered, but (refertum pilis) crammed with hair."

But there is, in fact, no end of wonders and wonderful dissections among these robbers of his. His next subject was not a bold robber, but a poor sneaking thief (de corde furis cujusdam); there was no hair to be expected in his heart: but as he was a thief only, it was consistent with this doctrine that he should be first very heartless; secondly, have very little brain; thirdly, that he should have very inordinate appetites and desires. Now, there was first a great two-legged vein carrying the atrabilis, the source, no doubt, of all his inordinate cravings, directly into the stomach; secondly, there was a great abscess full of pus wasting the left side of his heart; and, thirdly and lastly, the back part of the head (which all the anatomists of that time knew very well was the seat of memory) was in him so small that it could hardly contain a spoonful of that kind of brain: and this want was the reason (having

so little memory) that he was so persevering a thief; for let you whip him, banish him, clap him in the stocks, he forgot it straightway, and was back at his old tricks again, like a dog to his vomit.

But these are now almost forgotten, though, perhaps, the history of the absurdities of the human genius should no more be neglected than that of its beauties. Is it not delightful to feel, that after floating in this ocean of conjecture, after all these disorderly and wild dreams, we are come to have an idea of the heart, simple and beautiful; of a heart containing within itself two functions; first, the office of renewing the blood; secondly, the office of animating the arteries, and by them preserving in life and action the whole system of the body? These are the two offices which I shall now proceed to explain.

OF THE RESPIRATION OF ANIMALS.

ITS EFFECTS ON THE BLOOD.

The effects of oxydation then are, to redden the blood, to renew its stimulant power, and to communicate heat, not so much to the blood, as to the whole body through the medium of the blood, and to assist in the secretions and chemical changes which are incessantly going on in all parts of the system. This is accomplished by the perpetual and rapid motion of the blood through the lungs; and there it is exposed to our atmosphere, which is a mixed fluid very different from what we at first conceive, or what our ignorant wishes might desire to have it; not consisting merely of air fit to be breathed, but for the greatest part formed of an air which is most fatal to animal life, whence it has the name of *Azotic Gas*. Of an hundred measures of atmospheric air, we find twenty-one only to consist of vital or pure air, that is oxygen; seventy-nine consist of azotic air, or

nitrogen, as it is called, fatal to animal life; and one thousandth part only is fixed air, or carbonic acid, which is also an unrespirable air. But of these twenty-one parts of pure air, seventeen parts only are affected by respiration; so that in respiration we use much less than a fifth part, even of the small quantity of air which we take in at each breath.*

* Dr. Bostock, after having examined the various opinions of the best chemists who treat of the effects produced by respiration upon the air, concludes thus — "1. Air which has been respired loses a part of its oxygen: the quantity varies considerably, not only in the different kinds of animals, but in different animals of the same species, and even in the same animal at different times, according to the operation of certain external agents, and of certain states of the constitution and functions. Upon an average we may assume, that a man, under ordinary circumstances, consumes about 45,000 cubic inches, or nearly 15,500 grains of oxygen in 24 hours. 2. A quantity of carbonic acid is produced, the amount of which varies very much, according to circumstances, both external and internal: its quantity depends, to a certain extent, upon the quantity of oxygen consumed; but the two are not in exact proportion to each other; in a great majority of cases, the quantity of carbonic acid produced will be found to be less than that of the oxygen consumed; so that there will be a surplus quantity of oxygen more than is necessary for the production of the carbonic acid. In consequence of the variations which take place in the amount of the carbonic acid produced, it appears almost impossible to fix upon any number which may indicate the average quantity: but it may be stated to be somewhere about 40,000 cubic inches in 24 hours. This will weigh 18,600 grains, or nearly three pounds, and will contain 5,208 grains of charcoal, and 13,392 grains of oxygen, which will be 2,100 less than the quantity of oxygen consumed. 3. The volume of the air is diminished by respiration; but this, like the changes mentioned above, varies so much at different times, that it is almost impossible to form any statement of the quantity: perhaps we may assume, that air which has been *once* respired is diminished by about $\frac{1}{40}$ of its bulk. 4. It appears probable, that nitrogen is both absorbed by the lungs and exhaled from them; but the two processes of absorption and exhalation differ very much, both in their absolute quantity and in the relation which they bear to each other; so that the proportion of nitrogen in the air is sometimes diminished by respiration — is occasionally increased, and frequently remains without alteration. 5. A quantity of aqueous vapour is discharged from the lungs, mixed with or diffused through the air of expiration; but we have not sufficient data from which to decide upon its amount; and it is probable, that the quantity varies considerably in the different conditions of the

Within these few years, the following opinions prevailed on this subject. The air in respiration is diminished by the abstraction of a part of the oxygen; there is formed a quantity of carbonic acid gas by the union of the carbon of the blood with the oxygen respired; and there is discharged along with these a quantity of watery halitus. Therefore atmospheric air, after it has been breathed, is found to have suffered these changes: First, It contains now a considerable proportion of carbonic acid, which is easily discovered and even weighed, because, when a caustic alkali is exposed to it, the alkali absorbs the fixed air and becomes mild. Secondly, It has less of the vital air, as is easily ascertained by the eudiometer, which measures the purity of the whole: And, thirdly, All that remains is merely azotic air, unfit for animal life, or for supporting flame. The oxygen, then, in part unites itself with the blood; in part it forms fixed air by combining with the carbon of the lungs; in part it forms water by combining with the hydrogen of the blood. Respiration frees the blood of two noxious principles, the hydrogen and carbon; and it insinuates a new principle, viz. the oxygen, into the blood.*

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system, and the different situations in which the body is placed." *Bostock's Element. System of Phys.* vol. ii. p. 110.

* "Two theories have been proposed, in order to account for the phenomena of respiration. According to one theory, the carbonic acid found in respired air is actually generated in the lungs themselves: while, according to the other, this gas is thought to exist ready formed in the blood, and to be merely thrown off from that liquid during its distribution through the lungs.

"The former theory, which appears to have originated with Priestly, has received several modifications. Priestly imagined, that the phenomena of respiration are owing to the disengagement of phlogiston from the blood, and its combination with the air. Dr. Crawford modified this doctrine in the following manner (Crawford on Animal Heat): He was of opinion, that venous blood contains a peculiar compound of carbon and hydrogen, termed hydrocarbon, the elements of which unite in the lungs with the oxygen of the air, forming water with the one, and carbonic acid with the other; and that the blood, thus purified,

Such has been the opinion of chemists up almost to the present day; but the rapid changes of opinion, and, indeed, of whole systems, and the confusion into which the discoveries of the day throw the result of all preceding labours, would almost provoke an anatomist to put out of his system the chemical discussion altogether, until the masters of that science have arrived at acknowledged principles. More careful experiments have proved that the volume of air expired is very nearly the same with that inspired, — the respired air differing only in the variable proportion of carbonic acid gas, and aqueous vapour; that all the oxygen taken from the atmosphere by respiration is consumed in the formation of the carbonic acid gas found in the respired air; and that

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regains its florid hue, and becomes fit for the purposes of the animal economy.

"The hypothesis of Crawford, however, is not merely liable to the objection that the supposed hydrocarbon, as respects the blood, is quite imaginary, but was found at variance with the leading facts established by Messrs. Allen and Pepys. By the elaborate researches of these chemists, it was established, that carbonic acid gas contains its own volume of oxygen: and they also concluded, that air, inhaled into the lungs, returns charged with a quantity of carbonic acid, almost exactly equal in bulk to the oxygen which disappears; an inference which, as applied to man and some of the lower animals, seems very near the truth.

"A review of these circumstances induced them to adopt the opinion, that the oxygen of the air combines in the lungs exclusively with carbon: and that the watery vapour, which is always contained in the breath, is an exhalation from minute pulmonary vessels. They conceived that the fine animal membrane interposed between the blood and the air does not prevent chemical action from taking place between them.

"According to the second theory, which was supported by La Grange and Hassenfratz, and has lately been adopted by Dr. Edwards, carbonic acid, generated during the course of the circulation, is given off from the venous blood in the lungs, and oxygen gas is absorbed.

"In the experiments of Dr. Edwards, on confining frogs and snails for some time in an atmosphere of hydrogen, the residual air was found to contain a quantity of carbonic acid, which was in some instances even greater than the bulk of the animal; and a similar result was obtained with young kittens." *Turner's Elements of Chemistry*, p. 753.

the heat evolved by respiration is not the heat of the body, but the heat of the air respired, latent before, and now become sensible, owing to a change of capacity in the blood.

The change produced in the blood during the circulation in the lungs, is simply to free it of the superabundance of carbon with which it is loaded by circulation through the body.*

OF ANIMAL HEAT.

The next effect of respiration is the communicating of HEAT to the body. There are some who

* "In studying the subject of respiration, the first object is to determine the precise change produced in the constitution of the air which is inhaled. Dr. Black was the first to notice that the air exhaled from the lungs contains a considerable quantity of carbonic acid, which may be detected by transmission through lime water.

"Priestly, some years afterwards, observed, that air is rendered unfit for supporting flame or animal life by the process of respiration, from which it was probable that oxygen is consumed; and Lavoisier subsequently established the fact, that during respiration oxygen gas disappears, and carbonic acid is disengaged. The chief experimentalists who have since cultivated this department of chemical physiology are Priestly, Scheele, Lavoisier, Seguin, Crawford, Goodwyn, Davy, Ellis, Allen and Pepys, Edwards and Despretz; of these, the results obtained by Messrs. Allen and Pepys, and Dr. Edwards, are the most conclusive and satisfactory, their researches having been conducted with great care, and aided by all the resources of modern chemistry.

"One of the chief objects of Messrs. Allen and Pepys, in their experiments, was to ascertain if any uniform relation exists between the oxygen consumed and the carbonic acid evolved. They found, in general, that the quantity of the former exceeds that of the latter; but as the difference was very trifling, they inferred, that the carbonic acid of the expired air is exactly equal to the oxygen which disappears. The experiments of Dr. Edwards were attended with a remarkable result, which accounts very happily for some of the discordant statements of preceding inquirers. He found the ratio between the gases to vary with the animal. In some animals it might be regarded as nearly equal; while in others, the loss of oxygen considerably exceeded the gain of carbonic acid, so that the respired air suffered a material diminution in volume. With respect to the human subject, the statement of Allen and Pepys seems very near the truth." *Turner's Elements of Chemistry*, p. 750.

pretend to say, that when they draw in vital air, they feel a genial warmth in the breast, diffusing itself over all the body; but it is easy to feel in this way, or any way, when a favourite doctrine is at stake, while those who know nothing about doctrines breathe the vital air without any peculiar feeling which they can explain.

To suppose, but for a moment, that all the heat which warms the whole body emanates from the lungs, were a gross error in philosophy: it were to suppose an accumulation of heat in the lungs equal to the vast effect of heating the whole body. But, were it so, we should feel a burning heat in the centre, a mortal coldness at the extremities, and marked differences in the heat of each part, in proportion to its distance from the lungs. In fevers we should feel only the intense heat of the centre: we should be distressed, not with the heat in the soles of the feet or palms of the hands, or in the mouth and tongue, we should feel only the heat of the lungs. When the limbs alone were cold, would the lungs warm them? How could they warm them up to the right temperature without overheating the whole body? When a part was inflamed, how could the heat go from the lungs, particularly to that point, and rest there?

It is a law of nature, to which, as far as we know, no exception is found, that a body, while it passes from an aërial to a fluid form, or from a fluid to a solid form, gives out heat. So, it might be said, what is the whole business of the living system but a continual assimilation of new parts, making them continually pass from fluid into a solid form? But this would be an erroneous view of the matter.

It were easy to say, that the gases were consumed in breathing, and the fluids in circulation became solids, and therefore heat was generated in the animal body. But, unfortunately for this hypothesis, these solids are again melted into fluids, and the fluids are giving out gases; and then as much heat as we might suppose was generated in building up the fabric of the body would be lost in its decomposition.

This is a subject of much difficulty, as may be readily conceived, when we consider, that for its elucidation we require to measure the air, and estimate, not the temperature of that air, but the degree of heat it is capable of producing: we are consequently engaged with chemical processes of great delicacy. The received opinion is this; bodies and even fluids and gases have different capacities for heat, and the heat may make a part of their compound, without being in a state to raise their actual temperature: this property of latent heat was the great discovery of Black. Now it is said that the blood, when going out from the heart to the lungs, differs in its capacity of absorbing and retaining the heat from the same blood on its return; that the arterial blood, returning in the veins, contains more absolute heat, though it be not of a higher temperature than the blood of the veins. By the process of respiration, when the purple-coloured venous blood is exposed to the air, it throws out its superabundant carbon: and when this carbon unites with the oxygen of the air respired, carbonic acid gas is formed and heat is evolved. The arterial blood, it is supposed, takes up this heat, which is not sensible heat, but latent. It is further alleged, that when the arterial blood is conveyed along the tubes and vessels to the body, and generally diffused, it is not heating the body, because the latent heat is not disengaged, and is not in a state to raise the temperature. But when that arterial blood is converted into venous blood, a process which takes place in the extremities of the arteries and veins of the body, then the latent heat is disengaged, because the venous blood has not the same capacity for retaining it as the arterial blood had: and thus heat is uniformly diffused in proportion to the activity of the circulation—in proportion to the conversion of arterial into venous blood.

This highly ingenious hypothesis of Dr. Crawford has been objected to by Dr. Davy, Edwards, and others, who assert that there is no difference of capacity in the arterial and venous blood. And the phenomena are explained in this manner: it is said

that oxygen is absorbed by the blood returning from the lungs to the left side of the heart; that this oxygen, carried by the arteries over the body, unites with the carbon in the circulation through the body; and that it is during the assumption of this carbon, and the formation of carbonic acid, that heat is evolved. This appears to me to be a defective hypothesis, inasmuch as there are only two ways of explaining a change of temperature, — either by a difference of capacity of retaining what was formerly called *latent* heat, or by a difference in the aggregation or condition of the substances. They have rejected the hypothesis of the different capacities of heat. As to the other, they have not explained to us how the carbon, constituting a part of the solid texture of the frame, should give out heat when entering into the liquid blood, we may say when changing from the solid to the liquid state. We require a new genius to look over this subject, and to arrange the discordant materials. In the meantime, by rejecting the hypothesis of Crawford we are thrown into more confusion: but the truth is, that in every subject, where the experiments and reasoning of the chemist are brought to explain a vital phenomenon, he fails in being perfectly satisfactory.

It is by possessing this property of animal heat that we are enabled to resist the changes of external temperature, and maintain a genial warmth independently of the surrounding atmosphere. Thus man can inhabit all parts of the globe, however various are the degrees of heat in the different climates; and his temperature is always the same, being 97° or 98°. As to the means by which the uniformity of the animal temperature is thus preserved, the investigations of chemists have not yet conducted us to very satisfactory conclusions. It is supposed that the quantity of carbonic acid gas evolved from the lungs and the halitus may vary according to the altered state of the surrounding temperature; and it is also thought that the degree of perspiration of the skin, and the consequent evaporation, may vary in a

similar manner, so as to correspond with the warmth or coldness of the atmosphere—but of these the proofs by actual experiment are yet very deficient.*

OF THE MEMBRANES OF CAVITIES, AND PARTICULARLY OF THE MEMBRANES OF THE THORAX.

Every part of an animal body, with the exception of the fluids, the matter of the nerves, of the muscles, and of the bones, is resolvable into membrane by maceration, and the contrivances of the anatomist. The fine web which supports the retina in the eye, and the strong cord on which the gastrocnemius acts, are formed of the same kind of tissue, the same cellular texture. Another remarkable circumstance is, that this cellular texture no where terminates, and that the membranes of the body are every where in continuity. If, for example, we begin our investigation with the tendon of a muscle, we shall find that

* It was conceived, from the experiments made by Boerhaave, that persons could not live when exposed to a heat greater than that which is natural to the body. This was first disproved by Tillet, who gave the account of some young women, the servants of a baker at Rochefoucault, who were in the habit of going into the heated ovens at the temperature of 278°; and they could remain in them for about 12 minutes. Subsequent experiments have been made by Dr. Fordyce, Blagden, Dobson, and others; and it has been found, that although the temperature of the surrounding air be raised to 260°, the heat of the body suffered scarcely any change from its usual standard: it varied in their experiments between 98° and 100°. When many persons were together in the heated chamber, the temperature of the room was changed—it became much less. It was then supposed by Dr. Blagden, that independently of the cooling effects of the perspiration, their bodies had a property of abstracting and removing some of the heat. When they breathed upon the thermometer, the mercury fell—they cooled the tips of their fingers by blowing upon them. The pulse, during these experiments, rose, in some instances, to 130°. Their breathing was not affected.

Captain Lyon, while in Winter Isle, which is situated N. lat. 66° 11′, and while the temperature varied between 23° and 3°, made observations with the thermometer on recently killed foxes, and he found that the degree of heat of their bodies was always between 106¼° and 98°.

Dr. Davy states, that the standard heat of the inhabitants of Ceylon is two degrees above the usual standard.

it is resolvable into a twisted membrane, we may trace this membrane into the muscle, and we shall find it enveloping the muscular fibres, and extending through the muscle, and uniting again to form the tendinous insertion of the muscle into the bone. From the tendon the continuation is direct to the periosteum; the periosteum is continued into the ligaments and capsule of the joint; from this again we may trace the fasciæ, and intermuscular septa. These firmer structures we shall find loosening into the common cellular texture, and that texture, as has been already explained, may be traced over the whole animal frame.

But we have now particularly to consider the structure and connections of the membranes of the great cavities of the body; and, in the first place, the membranes of the thorax.

A membrane is an expansion or web of animal matter, having extension with a scarcely measurable thickness; it has one surface, free or disunited, and smooth, and lubricated with a secreted fluid. It has the other surface rough and attached, being more like the common cellular texture, of which, in fact, the whole membrane is a composition.

The membranes of the viscera are arranged in two grand divisions, viz. the Mucous membranes, and the Serous membranes; all of which are remarkable for their extent of surface, but especially the former. The difference of the two great classes of membranes is referable to the nature of their secretions. The object of the secretions is to prevent adhesion of contiguous surfaces, which is most effectually done by the mucous secretion. But as the mucous secretion is not readily soluble, nor prepared for absorption; as when secreted it must be thrown off from the surface, and urged out of the body altogether; it is obvious that this is a secretion calculated solely for the membranes which are open, and from which it may be discharged.

The serous fluid is finer, more watery, and very readily absorbed; so that it is supplied to moisten

the surfaces of shut sacs, and membranes which are continuous and have no outlet, such as those lining the great cavities. But if there be any tendency to inflammation on these surfaces, they are more prone to adhesion than the mucous membranes, because the inflammatory action will more quickly convert serum to coagulable lymph (which is the medium of adhesion) than it will the mucous secretion.

The mucous membrane is the continuation of the skin; it is every where continuous, but it admits of a natural division, viz. 1. The mucous lining of the lungs; 2. The mucous lining of the alimentary canal, and the ducts which open into it; and, 3. The mucous lining of the urinary organs.

We may trace the first from the nostrils up into the cavities of the nose, and from that into the lining membrane of the cells of the face. We may then trace it backwards into the throat, into the larynx, the trachea, the bronchia, and finally, into the bronchial cells, an extent perhaps equal to the whole surface of the body.

To trace these continuous surfaces is not an idle minuteness; for we require to know, that inflammation will creep along the surface by a prevailing action, which has got the name of continuous sympathy. Thus we are sensible in catarrh of a sense of pain and weight in the forehead, commencing with a dryness of the cavities of the nose; then we have increase of secretion, and tickling in the larynx; this is followed by pain and a sense of rawness in the throat; lastly, we have pain in the chest, or an uneasy tickling sensation in the very margin of the lungs, and thus the inflammatory action terminates only with the extremity of this long line of connection.

The second division of the mucous membrane is the lining membrane of the mouth, which we trace into the œsophagus, into the stomach, into the intestines; and, after a course of full seven times the length of the body, it appears on the verge of the anus, terminating, as it began, in the skin; and along the whole of this mucous lining we may some-

times trace the course of inflammatory action. An erythematous blush, visible in the throat, will sometimes take its course in a very dangerous manner, over the whole extent of the canal, even to the anus.

The third division of this membrane is where the fore-skin is reflected over the extremity of the penis into the urethra: here the mucous secretion commences, and it characterizes the whole extent of the canal, tracing it through the bladder to the pelves of the kidnies.

Thus we shall find, that the mucous membranes form the internal surface of all the hollow viscera, and now we shall also perceive that the serous membranes form the outward surface of the same viscera, investing both the solid and membraneous viscera with a common covering. The course of the serous membranes is, however, by no means so simple nor so easily comprehended by the student, as that of the mucous membrane: at the same time that they are reflected from one viscus to another, they form a shut pouch or sac. I shall at present confine myself to the anatomy of the membranes of the thorax or chest.

OF THE PLEURA.

The thorax is the superior cavity of the trunk, and contains the heart and great blood vessels, the lungs, and the thymus gland: it transmits into the abdomen the œsophagus and nerves; and these parts are involved and supported by the processes of the pleura.

By this it will be understood that there are two pleuræ: that which lines the central cavity has another name. Taking the membrane of one side we may thus describe it. The pleura is the fine serous membrane forming a bag which lines the cavities of the chest, and is reflected upon the lungs. We shall consider the pleura first as it lines the ribs (and where it is called PLEURA COSTALIS); secondly, where it is reflected on the diaphragm; thirdly, as

it forms the septum dividing the chest; fourthly, as it is reflected to cover the lungs (where it is the PLEURA PULMONALIS).

The PLEURA COSTALIS is the lining of the lateral walls of the chest. These walls consist of the ribs, their cartilages, and the sternum, their interstices being filled up with the intercostal muscles. The lining membrane of course is attached in part to the inside of the ribs, in part to the muscular texture which intervenes. It is a simple membrane; for so we call it, although, like every other membrane, it may be divided into layers of cellular membrane. On its outer surface it is more loose and cellular in its texture; on the surface towards the cavity it is smooth and bedewed with secretion, and is unattached or free. The pleura lining the ribs is very thin, and is immediately attached to the periosteum.

As the ribs and sternum form the walls of the chest on the lateral and fore parts, the diaphragm forms the floor of division betwixt the cavity of the chest and the lower cavity, or abdomen. From the ribs, the membrane is reflected upon the diaphragm, to which it adheres; and from the diaphragm and lateral parts of the chest, it is reflected to form the partition of the chest which is called mediastinum; which completes the circle of connections, as far as relates to the lateral cavity of the chest.

To understand whether or not we should speak of one or more membranes under the name of pleura, we must understand what is meant by cavity, and how many cavities there are.

We speak continually of the cavities, when correctly there are none in the animal body; for there is no empty space: the heart and lungs, with their membranes, lie in close contact. But when the anatomist exposes these viscera, the air rushes in, and there are then cavities. Or if, in the living body, air should escape from the lungs, or blood or secretion should be deposited betwixt the membranes, then, correctly speaking, such fluid lies in the *cavity*. It would, therefore, be affectation to use

any other term, and with this explanation no false conception can be formed.

Of such cavities there are three in the thorax, the cavity for the heart, nearly in the centre, and the two lateral cavities for the lungs. For although the lungs form one organ, yet being extended in two grand divisions laterally, and these divisions contained in different cavities, and embraced by distinct membranes, we speak of them as double, and call them the lungs.

The 1st *Plan* shows the two cavities of the thorax formed by the pleura costalis, and the septum or mediastinum formed by the meeting of the membranes.

The 2d *Plan* shows, by the continuation of the dotted line, how the *pleura costalis* is continued into the *pleura pulmonalis*.

In the first plan here, the dotted line represents the course of the pleura, in a supposed section of the chest. Two lateral cavities are seen with a partition; that partition or septum is the mediastinum, and passes from the spine to the sternum, dividing the chest into two lateral cavities. The second plan shows the manner in which the pleura is reflected to cover the lungs and form the pleura pulmonalis: a dotted line still marks the course of the membrane; and here we may observe, that when the pleura has formed the septum, called mediastinum, it is there again reflected over the vessels going to the lungs, and, covering the vessels, protects them, and forms what is called the ligament of the lungs. Tracing the membrane in its course, we do not find that it terminates any where; we find

that it is every where continuous, and that the pleura pulmonalis and pleura costalis are the same continued surface of membrane. So that were it possible to dissect it all out, without a hole in it, it might be blown up like a bladder. It is unnecessary to say that such a dissection will not be attempted.

But in these plans a liberty is taken to represent the lungs shrunk, and leaving the sides of the chest, a thing which never takes place in nature. This is done that my reader may follow the line distinctly; properly the surface of the lungs (that is, the pleura pulmonalis,) and the inner surface of the ribs (the pleura costalis) should have been in contact; for although we continually speak of the cavity of the chest, yet there is no cavity but in disease, or when by wounds the air is permitted to escape from the lungs, and then, indeed, the circumstances are as represented in this plan; for the lungs leaving the side of the chest, there is a cavity which is then filled with air.

When we trace the membrane of the ribs over the lungs, we comprehend how the smooth and proper surface of the one is internal and the other external, and yet that these surfaces are continuous and the same. We understand too how the surface of the pleura pulmonalis and costalis are in close contact, and yet do not adhere, and that consequently freedom is given to the motion of the lungs. At least, if in respiration the lungs do not move from the sides of the chest, they are not prevented by the adhesion of the pleura, when in a healthy and natural state, but by a circumstance already in part explained. The lungs cannot recede from the pleura covering the ribs, because no air can be admitted to fill the space which would be then necessarily formed betwixt the lungs and ribs.

The LIGAMENTS of the lungs are understood when my reader comprehends the manner in which the pleura is reflected from the ribs over the spine, and from the spine over the great vessels and over the lungs. Where this reflection of the pleura takes

13

place, embracing the tubes and vessels going to the substance of the lungs, it forms ligamentous roots, the only natural connection of the lungs to the chest.

The MEDIASTINUM is a partition dividing the great cavity of the chest into two lateral parts: it is stretched from the spine to the sternum. This is a common and it may be a true description of the mediastinum, as far as it goes, yet it is a most imperfect one. This partition of the thorax is esteemed a provision for our safety worthy of all admiration; and so, indeed, it is. But when it is said, that this partition provides that a man, being diseased in the lungs of one side, or wounded betwixt the ribs of one side, may still breathe with the other, I would venture to say, that it is a wrong reading in that volume which it ought to be our pride to preserve pure. Every motion of the natural system has its proper check; every delicate part has its guard against the violent motions of the natural system, and is constituted with a due provision against the injuries we are liable to in a state of nature. But nature had it not in contemplation that we should be exposed to the gun and bayonet; nor can I think, with a celebrated anatomist, that she has provided for sustaining the prolonged existence of him who is slowly wasted by pulmonary consumption. I cannot believe that there is either in the foramina of the heart, or the mechanism of the chest, a provision against the effects of disease. I have therefore to show that the mediastinum has a reference to the support of the heart and great vessels, against the unequal pressure to which, without this guard, they would be exposed in the necessary and natural changes to which the body is subject in health. But I have said that the description of the mediastinum is imperfect; and really, though seemingly simple, it is difficult to represent by words the connection of the membranes of the thorax.

The two distinct sacs of the pleura, each forming a lining membrane to the two sides of the thorax, approach towards the centre of the cavity, and would absolutely unite but for the intervention of the heart

and its appendages. And so, indeed, it is, that anterior to the heart and posterior to it these membranes nearly touch. Where the sacs of the pleura approach each other anterior to the heart, they form the ANTERIOR MEDIASTINUM; and in the same manner, behind the heart and near the spine, they form the POSTERIOR MEDIASTINUM.

The anterior or pectoral mediastinum has, in the embrace of the membranes, much cellular membrane; and when in dissection we raise the sternum, this loose cellular membrane allows the pleura to be drawn separate so as to form a cavity, which cavity did not previously exist. The anterior mediastinum contains the thymus gland, some absorbent glands, and a considerable trunk of the lymphatic system, which has been called the DUCTUS THORACICUS ANTERIOR.

The posterior mediastinum, called sometimes DORSALE, contains the extremity of the trachea and part of its branches called bronchia, and part of the pulmonic artery and veins; the œsophagus, for the greater extent of its course; the descending aorta, and the great trunk of the absorbents; the thoracic duct; the eighth pair of nerves; the vena azygos, and the dorsal lymphatic glands.

Both the mediastina are a little towards the left side, and the posterior one is much the longest.

I now leave authority, and proceed to describe the more important connections of the membranes of the chest with the heart and great vessels. The pleura, which is a very thin and weak membrane where it invests the lungs, or adheres to the inside of the ribs, is particularly strong where it is reflected from the diaphragm; and from the diaphragm to the upper and more contracted part of the chest, all along the tract of the cava, it is of a ligamentous firmness, and is more like a fascia or tendon than those layers of cellular tissue which have of late got that name in connection with the subject of hernia. Towards the upper part of the chest, the pleura, or rather the mediastinum, covers and embraces the

branches of the cava, and posteriorly it covers and protects the aorta and thoracic duct; in short, were it not for the fear of confounding the ideas of the younger student, I would say, that this structure of membranes excludes all but the lungs from the cavity of the chest, and consequently from the effect of the chest's motion in respiration. How the respiration does not affect the veins and cavities of the heart will now, I trust, be easily conceived, and consequently the use of the mediastinum be understood.

But before I proceed further, I must here observe, that the pleura where it is reflected to form the mediastinum is double; that is, the cellular texture acquires a different structure, has a ligamentous firmness, and performs the office of a fascia around the vessels, an office which could not have been done by the mere reflection of the lining membrane of the chest.

The enlarged capacity of the thorax in every direction, the raising of the ribs, the thrusting out of the sternum, is attended with the contraction and sinking of the arch of the diaphragm. But this motion, which expands the cavities of the chest, and consequently the cells of the lungs, and draws the air into them, would disorder the heart's motion, would cause a lodgment of the blood and distension of the great veins and sinuses, were they under the influence of the motion of respiration, as the lungs are. But the diaphragm moves chiefly on its lateral parts; it is checked and interrupted at the middle part by the connections of the mediastinum. In proportion as the lateral cavities of the chest, and the lungs consequently, suffer the influence of this expansion of the chest, and have the pressure taken from them, the parts contained in the mediastinum, on the contrary, suffer pressure by the action of the diaphragm and rising of the sternum. If the veins near the heart were exposed to the same influence to which the lungs are, they would be subject to the same change of quantity of what they contain; that is, the blood would be accumulated in inspiration, and forced out

from them in expiration, as the air is in the lungs, and the regular action of the heart would be thus interrupted or disturbed.

There is a further use in these connections of the membranes surrounding the great vessels with the diaphragm, viz. to support or produce an equal pressure upon the great vessels of the trunk during the violent actions of the body. Thus in leaping, pulling, or straining, there is a sudden and great pressure on the viscera and veins of the abdomen, and at the same time there is a powerful acceleration of the blood from every remote part towards the great veins and right sinus of the heart. These vessels would be overpowered and burst but for the protection of the mediastinum. It is then that we perceive the happy influence of the diaphragm, in drawing down the mediastinum, and consequently restraining and supporting the heart and great vessels.

OF THE PERICARDIUM.

The pericardium, or heart-purse, is the third cavity of the thorax; but here again I must caution my readers on the use of the term cavity. The pericardium closely embraces the heart, retains the lubricating fluid, and restrains and limits the heart's motion. But this being already explained, I have only to add a circumstance slightly noticed under the former head. The pericardium is a double membrane: the inner layer of membrane belongs to the class of serous membranes; the outer is quite of a different character, being a tissue of strong fibres which form a web as strong as a fascia. It is this external layer of the pericardium which is continued upon the great vessels as they arise from the heart, and which forms their supporting sheath; and what the closer texture of the sheath does to restrain and support the arteries and veins, is done by this outward layer of the pericardium of the heart.

The next point left unexplained is the manner in which the heart and pericardium are embraced by the pleura.

In this plan* we see how the heart, surrounded by the pericardium, is further embraced by the mediastinum, by which it is not only supported, but the great vessels are surrounded and led securely out of the thorax, until they reach their proper sheaths in ascending upon the neck, or passing out into the axilla.

OF THE THYMUS GLAND.

The thymus is a gland of a pale colour and soft consistence, having many divisions or lobuli. It lies immersed in the cellular membrane of the anterior mediastinum, but stretches upwards on the neck, and its extremities are betwixt the trachea and carotid arteries, but it lies principally on the pericardium. It has two superior cornua, and two inferior, the right of which is the longest. On puncturing this gland a white fluid may be expressed, and when we blow into this puncture the air pervades the whole gland, giving the appearance of a cellular texture: but no ducts have been discovered. The thymus occupies a very considerable space in the chest of the fœtus, while it diminishes rapidly during childhood; therefore it is presumed, that it has a function

* A, The heart. B, the pericardium. CC, the pleura of the right and of the left side, embracing the pericardium betwixt them.

adapted to some peculiarity of the fœtal circulation: but not even a probable conjecture has been offered further. It has been supposed a kind of diverticulum chyli; it has been supposed to secrete a fluid to attenuate the blood; it has been supposed to separate a peculiar fluid which was again thrown into the blood through the small veins; it has been supposed useful to fill up the thorax during the contracted state of the lungs in the fœtus; forgetting altogether that it is large in the fœtus, and diminishes after birth; it has been supposed to protect the lungs from the pressure of the sternum; all which are suppositions merely, that have not the most distant proof to support them, and yet possess not sufficient absurdity to make them worthy to be recollected on that account.

OF THE LUNGS.

The lungs are the soft compressible bodies which fill the two lateral cavities of the chest; and their use is to convey the atmospheric air into contact with the circulating blood. They consist principally of a cellular texture, and air tubes communicating with the atmosphere through the trachea. The degree of fleshy consistence and solidity which they have, is owing to the many vessels which carry blood through them, and the firm texture of membrane necessary to support them. Their function is respiration. It is through the larynx, trachea, and lungs, that we respire; and respiration is a complicated as well as an important function. It carries away the superfluous carbon of the blood; bestows heat, and stimulates the system; endows us with the power of speech; affords us the sense of smelling, or greatly contributes to the perfection of the sense; while the lungs bestow due buoyancy to the bodies of man and animals.

In form the lungs correspond to the cavity which contains them. When taken from their place and extended, they are wide below, forming a base, and rise conically upward; they are concave where they lie on the arch of the diaphragm, obtuse above, convex forward, and more slightly so on the sides; their borders behind are obtuse, while they are pointed, and thin before. The lungs have a deep sulcus behind, left for the spine, and within the projecting lobes there is a place of lodgment for the pericardium and heart.

Attending to this general form, we see why the lungs are spoken of as double, for, unless by the connection of their common wind-pipe, there are two great lateral portions, each of which belongs to a distinct cavity. And when we look to the lungs of the two sides, we discover that they are not perfectly alike. On each lung a fissure begins a little above the apex, and runs obliquely forward and downward to the base. This fissure on the left side divides the lung into two lobes. On the right side there is a lesser fissure, which consequently forms a less intermediate third lobe.

OF THE TRACHEA, OR ASPERA ARTERIA.

The TRACHEA is that extent of the wind-pipe which is betwixt the LARYNX (already described) and the forking or division of this tube where it is about to enter the lungs. It is seated on the fore part of the neck, and anterior to the œsophagus or gullet. Anteriorly it is covered by the thyroid gland and the flat muscles, which go from the sternum to the os hyoides and thyroid cartilage, and all around it has a very loose and elastic cellular membrane to permit it to move in breathing, swallowing, &c.

The trachea is not a perfect cylinder, it is quite flat on the back part and membraneous; it is rigid to admit of the easy passage of the air through it, and this rigidity is derived from the cartilaginous hoops of which it is principally formed. These hoops are not

perfect circles. They are deficient on the back part, and this deficiency is not only calculated to permit the tube to be flat on the back part, and to give place to the œsophagus, but to allow a more perfect elasticity; for the extremities of the cartilaginous hoops being free, their elasticity is thereby increased. The hoops of cartilage are not perfectly regular: above they are most so, and are broader; but they are more irregular, and have weaker cornua, the nearer the bifurcation: the cornua have transverse fibres uniting them, which appear to be muscular.

The membrane lining the trachea, and continued from the larynx into the cells of the lungs, is, as we have already said, a mucous membrane; it is soft, elastic, and vascular; but it has many pores or foramina opening upon it, especially about the larynx and epiglottis. These are the openings of the ducts of the bronchial glands, and on the outside of the membrane round and oval glands are visible. These glands are often diseased, inflamed, and ulcerated.* The moisture which bedews the trachea is a limpid, bland mucus, which subsides in water, unless air-bubbles be in it. The thinner part of this secretion is carried off by the air which passes through the trachea, and the thick matter is expectorated.

This secretion, which in the healthy state is of the consistence of thin jelly, transparent and of a bluish colour, becomes from inflammation of the catarrhal kind, thinner and more transparent, and is copiously expectorated. In more chronic inflammation the matter becomes thick, opaque, and of the colour of straw. And in a still later stage it may become purulent, without implying lesion of surface. The firmer nodules of viscid secretion which are brought up are probably from the sacculi laryngis.

From its exposed situation, its sensibility and vascularity, the membrane of the trachea is very sub-

* *Glandulæ bronchiales conglobatæ*, mentioned by different authors, are no more than the conglobate lymphatic glands, seated around the bronchia at the root of the lungs and in the mediastinum, and which belong to the lymphatics of the lungs.

ject to disease. I have now before me examples of general inflammation, of inflammatory crust, of suppuration, and deep ulcer in the inside of the trachea. Often lesser degrees of inflammation change the nature of the bland secretion, making it more saline, acrid, and stimulating. Sometimes the inflammatory action will mix a portion of coagulable lymph with the mucus secreted, and which, by this addition, will take a tubular form, as in the croup. But let it be remembered, that coagulable lymph in the form of tubes or vessels may be coughed up from the lungs, a consequence of blood poured into the bronchia, without the presence of inflammation.

OF THE THYROID GLAND.

The thyroid gland is composed of two distinct glandular portions, of an oblong shape, which occupy the sides of the larynx, and which are united at their lower part by a narrow isthmus or band extending across the trachea below the cricoid cartilage. It varies considerably in its shape and size. But each lobe is generally thickest at its lowest end, and as it ascends gets more peaked. At its lower part it comes more forward, and partially embraces the two uppermost rings of the trachea; but higher up, it recedes backwards so that the uppermost point lies more upon the inferior constrictor pharyngis than upon the thyroid cartilage. The sterno-thyroidei, sterno-hyoidei, and omo-hyoidei muscles all cover the gland. It clings around the larynx, and follows it in all its motions. Each lobe lodges upon the sides of the first rings of the trachea, and part of the cricoid and thyroid cartilages. The muscles upon which it lies are the crico-thyroidei, thyro-hyoidei, and inferior constrictor of the pharynx. Sometimes there is a slip of muscular fibres descending from the os hyoides, and which expands upon its surface: this has been called the levator glandulæ thyroidæ — but it is not always present. Sometimes muscular fibres are seen extending over the gland, appearing to be a part of the crico-thyroideus muscle. On cutting into the gland

its texture is seen to be very vascular, and a watery or viscid secretion can be squeezed from the cut surface. It is subdivided into distinct lobules, but these are not so obvious as in the salivary glands. Anatomists have failed in discovering an excretory duct for this gland; yet some have mistaken a vessel for it. It is observed to be in general larger in the female than in man — it is also observed to be proportionally larger in the fœtus than in the adult. Whatever other function may be discovered to be the office of this gland, I conceive it to be, in an essential degree, part of the organ of the voice: that the muscles which are over it compress it against the cartilages of the larynx, and influence their vibrations.

OF THE BRONCHIAL TUBES.

On entering the thorax the trachea inclines backward, and passes into the posterior mediastinum, and behind the arch of the aorta, and before the œsophagus; opposite to the third vertebra of the back it divides into two branches, passing to the right and left; these and their subdivisions are the bronchia.

When we follow one of these tubes, we find it entering the substance of the lungs, accompanied by blood vessels, branches of the pulmonary artery, with their corresponding veins; and lesser arterial branches enter here, which are derived from the aorta, and are called the bronchial arteries.

The bronchia divide and subdivide in regular order, branching like a tree through all the substance of the lungs, until their tender extremities terminate in the air-cells; for the cartilages of the bronchia, which near the trachea resemble those of the trunk, become annular and weaker, more oblique, irregular, and further removed from each other, until the extremities are little more than membraneous tubes.

OF THE BRONCHIAL CELLS.

The BRONCHIAL CELLS, into which the air is admitted in respiration, have been represented as very

regular sphericles attached to the branches of the bronchia, and having no communication with each other, but held together by a minute cellular texture. Malpighi described them as round vesicles, as if the branches of the bronchia were dilated into clusters of distinct bags. Willis described them like myrtle-berries on the stalk. Hales estimated that those cells were in diameter the hundredth part of an inch, and the extended surfaces of them 1035 square inches. Keil estimates their whole number to be 1,744,186,015.*

Various attempts have been made to ascertain how much air the lungs are capable of containing when distended, and of emitting when the chest is compressed: but we cannot depend on their results being very precise. It is pretty generally agreed that, on an average, 40 cubic inches are alternately taken in and expelled at each ordinary act of respiration. It is supposed that about 170 cubic inches more may be forcibly expelled after a common expiration, as by coughing, straining, &c.; and that after this the lungs shall contain within them 120 cubic inches. Proceeding upon this estimate, after an usual expiration there remain 290 cubic inches of air in the lungs; and upon inspiration there are 330, which is the measure of the capacity of the lungs in their distended state. Since 40 is about the $\frac{1}{8}$th of 330, it follows that it is only this small proportion, the $\frac{1}{8}$th part of the whole air in the lungs, which undergoes a change during each successive act of respiration. And we possess the power of expelling, by a forcible expiration, fully two thirds of the entire quantity.†

So far back as 1788, Dr. Goodwyn, to whom physiology is much indebted, proved that during the different states of expiration and inspiration the lungs are sufficiently capacious to permit the circulation to proceed uninterruptedly from the right to the left side of the heart. Before his experiments a

* Hales, Keil, and Leiberkuhn, differ greatly in estimating the conjoint extent of the vesicular surface.

† See Bostock, *Elem. Syst. of Physiol.* vol. ii. p. 25.

confused notion prevailed that the actions of respiration, the alternate dilatation and compression of the lungs, was for the purpose of aiding the circulation of the blood from the right to the left side of the heart. What has thrown obscurity over this subject is the interrupted flow of the blood from the head into the chest during expiration. Physiologists have attributed to the condition of the lungs that which is more properly referrable to the condition of the heart, during the changes to which it is exposed by the action of the diaphragm on the mediastinum in respiration.*

On the bronchial cells the ultimate branches of the pulmonary arteries and veins ramify and inosculate, and the thin membrane of the cell and the coats of these minute vessels do not prevent the influence of the air upon the circulating blood. My reader must well distinguish betwixt this regular cellular structure, for the admission of air which is drawn through the trachea and bronchia, and that cellular texture of the lungs which is common to them and every part of the body; this tissue which supports the air-cells, the bronchia, and the three several kinds of blood vessels, and the lymphatics which collectively constitute the substance of the lungs. This common cellular substance supports the air-cells, and unites the lobules, and conveys the vessels to their destination.

Some have contended that there was a muscular tissue around the bronchial cells; but it is impossible to demonstrate this, and I must presume physicians have allowed themselves to be misled by symptoms during life.

Sometimes the air escapes from the proper bronchial cells into the cellular texture; then there is emphysema of the lungs; then the lungs are distended with air; but that air does not minister to the oxygenation of the blood, on the contrary the patient dies suffocated. And still more frequently

* See vol. ii. p. 50.—See also "The Connection of Life with Respiration," by Dr. Goodwyn.

it happens that the lungs being over exerted, as by long-continued difficult respiration, a watery or mucous effusion takes place into the common cellular texture of the lungs, which effectually compresses the proper air-cells, and after much oppression suffocates.

OF THE ORGANS OF THE VOICE.

The organs of speech are very complicated. We shall first consider how simple sounds are produced, and then how these sounds become articulated and expressive of thought. It has been disputed what is the proper seat of the voice; and the difficulty of determining this has arisen from not distinguishing what is essential to the vibration which produces sound, and what aids that primitive organ in giving the voice strength and variety of tone. For the voice commences in the larynx, but reverberates downwards into the trachea, and even into the chest, whilst it may be directed with different effects into the cavities of the head and mouth and throat.

The organ of the voice is neither strictly speaking a stringed instrument, nor a drum, nor a pipe, nor a horn, but it is all these together; and we will not be surprised at this complication if we consider that the human voice is capable of every possible sound — that it can imitate the voice of every beast and bird — that it is more perfect than any musical instrument hitherto invented, and, in addition to every variety of musical note, it is capable of all combinations in articulate language to be heard in the different nations in the earth. The essential and primary part of the organ is these cords, with which the reader is already acquainted, the thyro-arytænoid ligaments, or cordæ vocales. The membrane lining the larynx is reflected over these ligaments, so as to be drawn by them in their motions, and this is what is meant when it is said the organ is like a drum; for these membranes must vibrate in the air. The muscles of the arytænoid cartilages draw tight the

cordæ vocales and their attached membranes, and thus giving them a certain tension, and the air being expelled forcibly from the chest at the same time, they cause a vibration of these ligaments and membranes. This vibration is communicated to the stream of air, and sound is produced. This sound, as we have said, may reverberate along all the passages from the lungs to the nostrils; but unless there be a certain vibration in these cords of the larynx, there is no vocalization of the breath. For example, a man, in whispering, articulates the sounds of the mere breath, without that breath being vocalized and made audible by the vibrations in the larynx.

In singing, the vocalized breath is given out uninterruptedly through the passages, the rising notes in the gamut being produced first by the narrowing of the glottis, and secondly, by the rising of the larynx towards the base of the skull. Physiologists, and among the rest Richerand and Majendie, make a comparison between the wind-pipe and a flute or flageolet. The lower notes of the instrument are sounded when the fingers cover all the ventiges, and the sound goes down through the whole tube; but as the fingers are raised in succession from below, the effect is as if portions of the tube were cut off, and the shorter the tube the higher the note. We understand then that the sounding tube of the human voice being lengthened will give out grave sounds, and these will be higher or more acute as the tube is shortened. But those physiologists have fallen into the mistake of believing that the trachea is this tube: now unfortunately the trachea is elongated in proportion as the higher note of the gamut is sounded by the human voice. The comparison should have been instituted between that portion of the air-tube which is above the chink of the glottis, and then the resemblance is just. In the graver notes, the larynx is drawn down, and the lips protruded; and in the higher notes the larynx is elevated to the utmost, and the lips retracted.

The vowels, as every body knows, are those uninterrupted sounds which, commencing in the vibration of the larynx, are modified, in ascending, by the epiglottis, velum pendulum palati, uvula, tongue and lips, as a. e. i. o. u. The liquid consonants are those sounds which are partially interrupted by the motion of the tongue, as in l, whilst a sort of continued sound or drone is permitted. The proper consonants are shorter sounds, when the open sound or vowel is suddenly interrupted by the articulating motion in the tongue and lips, as f. Those are called explosive, when the mouth opens to give the sound sudden passage, as t. The nasal consonants are those where, although the sound be interrupted in the mouth, it is made to circulate or vibrate in the cavities of the head: of this you may become sensible by putting your hand upon your forehead in sounding the letters m and n.

Thus the voice may be divided in the sound which you make in whispering; when the breath is modulated and articulated in the mouth, but not vocalized. 2dly. You have it vocalized by the primary vibrations of the cordæ vocales: and these sounds, though not articulated, may vary to every note of the gamut, and receive an almost infinite variety of intonations, by reverberation on the different parts of the prolonged and varied surfaces of the trachea, larynx, pharynx, mouth, and cavities of the nose. Lastly, the vocalized breath may be articulated, that is, variously interrupted by the tongue, teeth, and lips, and become expressive of conventional language. The uninterrupted sounds are the natural language, being expressive of the same emotions in the whole family of mankind; but the articulate language is a system of arbitrary signs confined to countries or divisions of the earth. Imperfect as this last appears to be, it is capable of high perfection, and aids in a remarkable manner the developement of the intellectual powers.

The author has a paper in preparation for the

Royal Society, in which some of these subjects are treated of; but it is principally to show that there has been a singular omission in the accounts hitherto given of the organs of the voice, more especially of articulate sounds.

OTHER TUBES OR VESSELS WHICH ENTER INTO THE TEXTURE OF THE LUNGS.

Although the blood-vessels which enter into the composition of the lungs are described elsewhere, yet, as they really constitute the more solid substance of the lungs, we may shortly review them here.

The blood-vessels which cling to the bronchia are called the VASA BRONCHIALIA. There are two, sometimes three, arteries of that name. There are one or two branches from the anterior part of the descending thoracic aorta; sometimes a branch from the superior intercostal artery; sometimes one from the subclavian artery. These, taking a serpentine course, cling to the air-tubes within the lungs. They at the same time send branches to the mediastinum, bronchial glands, œsophagus, and pericardium.

These are arteries to supply and nourish the membranes, glands, bronchia, and the other blood-vessels themselves.

The BRONCHIAL VEINS which correspond with the arteries. These are two, distinguished as right and left. The first commonly joins the vena azygos. The latter goes into the superior intercostal vein.

The next is the PULMONARY ARTERY, that which arises from the right side of the heart to carry the dark blood into the lungs: the other great artery of the system, as distinguished from the aorta. This artery, bending towards the lungs, divides and sends its grand right division behind the aorta and the superior cava, and before the right bronchia. The

left branch is shorter and straighter, and diverges to its destination. Both of these dive into the substance of the lungs, and can be traced to great minuteness. These arteries terminate, like the branches of the aortic system, in veins. This was the first part of the great circulation discovered; and it was an ancient experiment to push coloured fluids from the artery into the veins of the lungs. On the vesicular lungs of the cold-blooded animals, by the assistance of the microscope, the blood can be seen moving directly from the arteries into the veins. The pulmonic veins receiving this blood, and gathering together their branches from the whole substance of the lungs, form trunks, and terminate in the left auricle.

The lymphatics of the lungs form yet another set of vessels, constituting the substance of the lungs. They come out superficially in great profusion, and run their course along the ligaments of the lungs to the thoracic duct. Most of them run into the conglobate or lymphatic glands in the posterior mediastinum, called glandulæ Vesalii. The nerves of the lungs are the branches of the par vagum, and of the great sympathetic nerve.

These parts combined constitute the soft spongy substance of the lungs, which the ancients, without much enquiry, called the parenchymatous substance.

COURSE OF THE BLOOD IN THE LUNGS.

Coloured water, or size, or oil of turpentine, being injected into the pulmonary artery, comes back by the pulmonic veins, running in what is called the lesser circulation. The same fluids being injected into the vein, return by the artery.* The fluid

* In an experiment which was made by a pupil of mine, the mercury, which was thrown into the crural vein of a live ass, was found at the end of a month to be lodged in the cells of the lungs: it had not been forced into the pulmonary veins.

being more forcibly propelled into the pulmonary artery, flows by the trachea; and the exudation of the fluid is facilitated, if the action of respiration be imitated by blowing into the trachea at the time of the injection. These coarse experiments in the dead body prove little; but the course of the blood from the extreme pulmonic arteries into the veins, having been seen in the membranous lungs of the lacertæ, the chymical phenomena exhibited by respiration leave little for us to wish further in explanation of the functions of the lungs.*

There are some reflections which naturally occur in taking leave of this subject of respiration, which may have the further effect of confirming in my reader the accurate knowledge of the anatomy.

OF THE MOTIONS OF THE THORAX AND OF RESPIRATION IN MAN.

We have understood, by our studies of the skeleton and of the muscular system, how admirably adapted the thorax is to dilatation and contraction; and how the muscles act upon the bony and cartilaginous apparatus for this purpose. We have seen also that the cartilages are added to the ribs and sternum, to give them elasticity, and consequently strength, or at least a principle of resistance. This elasticity of the texture of the thorax serves another purpose: it preserves the chest in a middle condition between its utmost state of contraction and of dilatation, and tends to preserve life.

Let us now understand what takes place in the drawing of the breath.

* For the consent or sympathy of the lungs with other parts, see the observations under the head of *Par vagum*, in the description of the nerves.

This figure represents a section of the body—(*a*) the thorax—(*b*) the abdomen. These two cavities are divided by the diaphragm, which is represented by the arched line (*c*); for the diaphragm assumes this arched form especially in expiration. When the effort is made to inspire, the diaphragm descends, and then its state may be represented by the dotted line (*d*). As the diaphragm descends, it of course compresses the viscera in the abdomen (*b*), and this pushes out the abdominal muscles in the form of the dotted line (*f*); at the same time that the diaphragm and the abdominal muscles have changed their condition, the ribs are expanding, and the breast-bone (*e*) is rising, so that the thorax is enlarging in all its diameters. This being the act of inspiration, we easily understand expiration to be the return of these parts to their original condition, *i.e.* the descent of (*e*); the falling in of (*f*); and the rising of (*d*) to (*c*.)

Let us now take a front view of the thorax, so that we may have our notions of the action confirmed and corrected. We have the cavities of the thorax divided by a dotted line; and the floor of these cavities formed by the arch of the diaphragm (*aa*). When the diaphragm contracts and descends, it cannot uniformly descend as represented in the lateral plan; for we have understood that it is tied

up by the mediastinum. The perpendicular dark line represents the mediastinum. Thus the arch (*aa*), instead of descending in a single arch, acts on its lateral parts principally, and assumes the form (*bb*). As it was formerly explained, it acts on the lungs more than on the heart and vessels.

The student who has attended to the anatomy and relations of the lungs, must perceive that the rising and falling of the chest, and the propulsion upwards of the diaphragm (by the abdominal muscles), and its descent, must influence the lungs, alternately drawing the atmospheric air into them and expelling it; and thus the act of respiration is performed, the lungs being passive. He must perceive that by this mechanism, in which the whole muscles of the neck, chest, and abdomen, and back, are concerned, there is a continual exercise and an incessant motion or agitation of all the viscera. No doubt this is conducive to their proper function and to health. He

will no doubt also observe that this extensive apparatus of bones, cartilages, and muscles, serve other purposes than of mere breathing: that they assist the circulation of the blood: that they are agitated in speaking, coughing, laughing, crying, smelling, vomiting, the expulsion of fæces, &c. He must perceive this importance in the œconomy, and must surely be desirous of knowing how they are combined and animated; for which see the Nervous System. The action of the diaphragm on the circulating vessels is a subject which for the present I must reserve.

Although the lungs are very often found adhering to the inside of the chest, and although this union occurs where we cannot discover that the person during life was subject to any inflammation of the chest, yet it is a preternatural appearance. The lungs (covered with the pleura) lie in contact with the sides of the chest, and consequently with the pleura costalis, but without adhesion. They are passive in the motion of respiration. The muscles of respiration clothing the thorax are the agents in this function. The bony and cartilaginous texture of the thorax is the machinery put in motion, and the effect is the dilatation of the lungs; for as the sides of the chest rise, the lungs being in close contact, they must follow this rising; and as the dilatation of the lungs is freely permitted by the entrance of the atmosphere through the trachea into their cells, the effect of the action of the muscles of inspiration is the drawing of the atmospheric air into the bronchial cells, and the contact of that air with the blood circulating in the lungs. In expiration the lungs are equally passive as in inspiration. The muscles which contract the diameters of the thorax force the compages of bones and cartilages upon the lungs, and, compressing them, throw out the air by the trachea.

That any other idea should arise in the student's mind is owing to two circumstances; first, the not comprehending the principles of natural philosophy,

and puzzling himself with the expression that the air fills the lungs by its weight; which is true, but it is as true that the milk enters the mouth of a sucking infant by the weight of the atmosphere, or that in using a syringe, it is the weight of air which forces the fluid into the syringe. The air enters the lungs by suction; the motion of the thorax produces that suction; or, in other words, the operation of the weight of the air is permitted to take effect by the tendency to a vacuum which the rising of the sides of the thorax produces; the pressure of the atmosphere then causes the air to descend into the bronchial cells.

The second circumstance which gives occasion to misconception, is the lungs seeming to have a motion independent of the chest.

Thus, when a man is wounded betwixt the ribs, the lungs protrude, and this rising of the lungs appears to be owing to a power inherent in them: but attention to the true circumstance will explain the occasion of this. When the wound is received the air enters the chest, and the lungs fall collapsed; the cavity is therefore *full of air*, and the lobes of the lungs hang loose. The air plays freely out and in through the hole in the chest. But when by change of posture the flapping edge of the lungs falls against the hole in the side, the air which is in the chest can no longer make its exit, without forcing the lungs through the wound. Accordingly, in the act of expiration, the same compression which forces the air out in breathing pushes out the lungs from the side. We may have the proof from anatomy that the lungs lie in close contact with the pleura costalis.

When the intercostal muscles are dissected off, and the pleura costalis exposed, the surface of the lungs is seen in contact with that transparent membrane; and when the pleura is punctured with the lancet, the air rushes in, and visibly the lungs retire in proportion as the air is admitted. This proximity of the lungs to the ribs explains the effect of fracture of these bones in producing the tumour called em-

physema, for thus it happens: the bröken end of the rib, piercing the pleura costalis, tears also the pleura pulmonalis, and breaks the surface of the lungs, and opens the bronchial cells. Now when the chest is expanded, a little air is drawn through the rugged opening, and lodges in the cavity of the chest (now truly a cavity, the air occupying the space betwixt the lungs and chest). By little and little the small portion of air which is drawn into the cavity of the chest at each inspiration accumulates until a distressing quantity fills the whole of that side of the chest.

The chest being now full of air, the action of expiration, compressing the air in the chest, it insinuates itself by the side of the fractured ribs into the cellular texture, consequently a crepitating tumour of air is formed over the part hurt, and this quickly extends over the whole body, until the skin is blown up like a sack, and the man is in danger of suffocation. The suffocation is not a consequence of this distension of the cellular substance of the body, but of the fulness of the cavity of the chest on that side wounded. For at length, the chest being kept distended, and the diaphragm pushed down, and the mediastinum pressed to the opposite side, both sides of the chest are oppressed, and the breathing is so checked, that if not quickly relieved, the patient would die.

These plans will explain the common case of emphysema:

The emphysema of the body may take place in a different way.* The lungs may be diseased; air may be drawn through the abscess, and collect in the cavity of the chest; or the bronchial and true air-cells may be hurt by exertion, so that the air gets access into the common cellular texture of the lungs; and from the lungs it may find its way bewixt the ligaments of the lungs into the cellular texture of the mediastinum, and hence up into the neck and over the body. These last instances are rare compared with that proceeding from fractured rib.

* The first plan exhibits a section of the throax, with the rib broken A, and entering the lungs D. Air has already begun to accumulate in the cavity of the chest B. The air insinuating itself by the side of the broken rib, forms the tumour on the side C. The second plan exhibits the extent of the evil. The lungs D are compressed. The cavity of the chest left by the retraction of the lungs is full of air. The emphysematous tumour C is extended over the body. The right side of the diaphragm E is pushed down, and the heart and mediastinum F are forced towards the opposite side, encroaching on the lungs of the left side.

END OF THE FIRST VOLUME.

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